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Contents

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0.19 mm.; thickness, 0.12 mm. Fairly common. Cushman and McCulloch (1940) describe this variety as occurring from Cordova, Alaska, in 2 fm. to off Guadalupe Island, Mexico, in 50 fm.

Genus **Astrononion** Cushman and Edwards, 1937

Astrononion gallowayi Loeblich and Tappan

Plate 8, figure 1

Astrononion stellatum CUSHMAN and EDWARDS, 1937, (not *Nonionina stellata* TERQUEM, 1882), Contr. Cushman Lab. Foram. Res., vol. 13, p. 32, pl. 3, figs. 9-11.—CUSHMAN and McCULLOCH, 1940, Allan Hancock Pacific Exped., vol. 6, no. 3, p. 168, pl. 18, fig. 11.—CUSHMAN and TODD, 1947, Cushman Lab. Foram. Res., Spec. Publ. 21, p. 13, pl. 2, fig. 15.—CUSHMAN, 1948, *ibid.*, Spec. Publ. 23, p. 56.—F. L. PARKER, 1952, Bull. Mus. Comp. Zool. Harvard, vol. 106, no. 9, p. 410, pl. 5, figs. 2, 3.

Astrononion stelligerum (D'ORBIGNY). CUSHMAN, 1948, Cushman Lab. Foram. Res., Spec. Publ., no. 23, p. 55, pl. 6, fig. 6.

Astrononion gallowayi LOEBLICH and TAPPAN, 1953, Smithsonian Misc. Coll., vol. 121, no. 7 (publ. 4105), pp. 90-92, pl. 17, figs. 4-7.

Diameter of hypotype, 0.43 mm.; thickness, 0.18 mm. Rare in Sunset Bay tide pools. Cushman and McCulloch (1940) record this species near the Channel Islands off California, and close to Guadalupe Island, Mexico.

Genus **Elphidium** Montfort, 1808

Elphidium cf. **E. incertum** (Williamson)

Plate 8, figure 2

Diameter of figured specimen, 0.34 mm.; thickness, 0.13 mm. Very common in Sunset Bay tide pools. There appear to be two size groups. The smaller sizes, 0.27-0.35 mm. in diameter, are most numerous, and have from 8 to 10 chambers in the last whorl. The large specimens, averaging 0.50 mm. in diameter, are rare, perhaps one in 50, and characteristically have 12 chambers in the last whorl.

Elphidium subarcticum Cushman

Plate 8, figure 3

Elphidium subarcticum CUSHMAN, 1944, Cushman Lab. Foram. Res., Spec. Publ. 12, p. 27, pl. 3, figs. 34, 35; 1948, *ibid.*, Spec. Publ. 23, p. 58, pl. 6, fig. 12.—F. L. PARKER, 1952, Bull. Mus. Comp. Zool., Harvard, vol. 106, no. 9, p. 412, pl. 5, fig. 9. —LOEBLICH and TAPPAN, 1953, Smithsonian Misc. Coll., vol. 121, no. 7, p. 105, pl. 19, figs. 5-7.

Diameter of hypotype, 0.55 mm.; thickness, 0.23 mm. Specimens vary in diameter from 0.45 to 0.77 mm. Common at Sunset Bay. Loeblich and Tappan (1953) describe a row of pores, but no slit, at the base of the apertural face. This condition appears to occur in the Sunset Bay specimens when the base coincides with a suture in the preceding coil. This species occurs off the coast of New England (Cushman, 1944) and northern Alaska (Loeblich and Tappan, 1953).

Genus **Elphidiella** Cushman, 1936

Elphidiella nitida Cushman

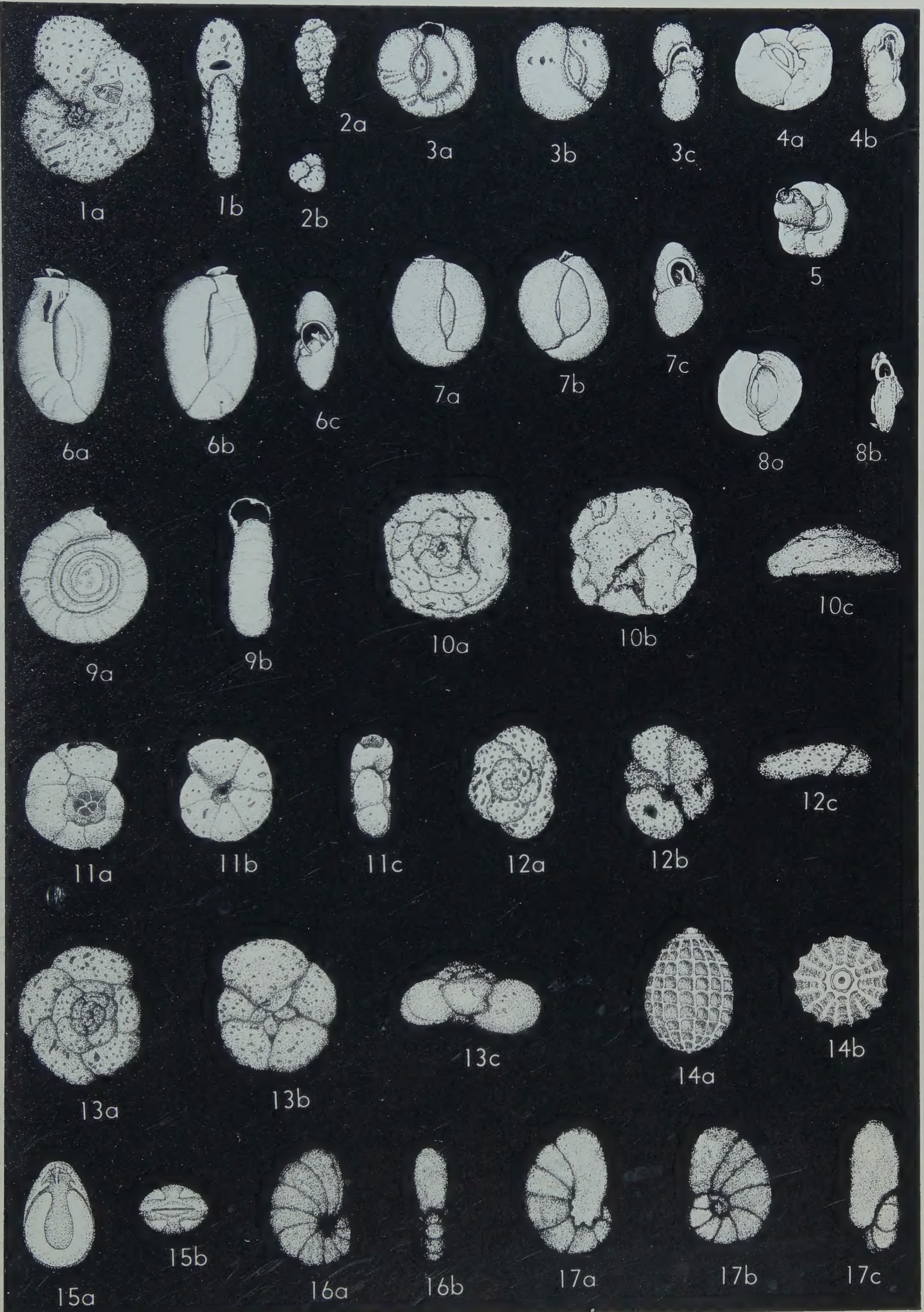
Plate 8, figure 4

Elphidium hannai CUSHMAN and GRANT, var. 1927, Trans. San Diego Soc. Nat. Hist., vol. 5, p. 78, pl. 8, fig. 2.

Elphidiella hannai (CUSHMAN and GRANT). CUSHMAN, 1939 (part), U. S. Geol. Surv. Prof. Paper 191, p. 66, pl. 19, fig. 2 (not fig. 1).—CUSHMAN and McCULLOCH, 1940, Allan Hancock Pacific Exped., vol. 6, no. 3, p. 177, pl. 20, fig. 11.—CUSHMAN and TODD, 1947, Cushman Lab. Foram. Res., Spec. Publ. 21, p. 15, pl. 2, fig. 22.

EXPLANATION OF PLATE 7

FIGS.		PAGE
1.	*Haplophragmoides columbiense* Cushman. × 50. a, side view; b, apertural view.	25
2.	*Eggerella advena* (Cushman). × 35. a, side view; b, apertural view.	25
3-5.	*Pateoris hauerinoides* (Rhumbler). × 23. a, b, opposite sides; c, apertural views; 5, irregularly shaped individual.	26
6.	*Quinqueloculina* sp. A. × 28. a, b, opposite sides; c, apertural view.	26
7.	*Q.* sp. B. × 33. a, b, opposite sides; c, apertural view.	26
8.	?*Q.* sp. C. × 18. a, side view; b, apertural view.	26
9.	*Cornuspira involvens* (Reuss). × 60. a, side view; b, apertural view.	26
10.	*Trochammina charlottensis* Cushman. × 35. a, dorsal view; b, ventral view; c, edge view.	26
11.	*T. inflata* (Montagu). × 42. a, dorsal view; b, ventral view; c, apertural view.	26
12.	*T. rotaliformis* Wright. × 30. a, dorsal view; b, ventral view; c, edge view.	26
13.	*T. discorbis* Earland. × 60. a, dorsal view; b, ventral view; c, apertural view.	26
14.	*Oolina melo* d'Orbigny. × 60. a, side view; b, apertural view.	27
15.	*Fissurina lucida* (Williamson). × 56. a, side view; b, apertural view.	27
16.	*Nonion grateloupii* (d'Orbigny). × 60. a, side view; b, apertural view.	27
17.	*Nonionella miocenica* Cushman, var. *stella* Cushman and Moyer. × 68. a, side view; b, apertural view.	27



Detling: Littoral Foraminifera, Oregon

Detling: Littoral Foraminifera, Oregon

Elphidiella nitida CUSHMAN, 1941, Contr. Cushman Lab. Foram. Res., vol. 17, pt. 2, p. 35, pl. 9, fig. 4.—LOEBLICH and TAPPAN, 1953, Smithsonian Misc. Coll., vol. 121, no. 7, p. 107, pl. 19, figs. 11, 12.

Diameter of hypotype, 0.78 mm.; thickness, 0.33 mm. Very common in Sunset Bay tide pools. The occurrence of "the fine granules present on the apertural face and on the periphery of the preceding whorl just in front of the aperture" (Loeblich and Tappan, 1953), was only occasional on the specimens from Sunset Bay. Fewer than 10 percent of the individuals possessed the character. Cushman and McCulloch (1940) record this species from a continuous series of stations from off Cordova, Alaska, to Cedros Island, Mexico. Fossil evidence of this species appears in the Pleistocene at Cape Blanco, Oregon and the Pliocene in the Humboldt in northern California (Cushman, Stewart, and Stewart, 1949).

Family BULIMINIDAE

Genus **Buliminella** Cushman, 1911

Buliminella elegantissima (d'Orbigny)

Plate 8, figure 5

Bulimina elegantissima D'ORBIGNY, 1839, Voy. Amér. Mérid., vol. 5, pt. 5, "Foraminifères," p. 51, pl. 7, figs. 13, 14.—WILLIAMSON, 1856, Rec. Foram. Gt. Britain, p. 64, pl. 5, figs. 134, 135.—H. B. BRADY, 1884, Rep. Voy. *Challenger,* Zoology, vol. 9, p. 402, pl. 50, figs. 20-22.

Buliminella elegantissima (D'ORBIGNY). CUSHMAN, 1919, Proc. U. S. Nat. Mus., vol. 56, p. 606.—CUSHMAN and TODD, 1947, Cushman Lab. Foram. Res., Spec. Publ. 21, p. 15, pl. 3, fig. 1.—CUSHMAN and McCULLOCH, 1948, Allan Hancock Pacific Exped., vol. 6, no. 5, pp. 236-238, pl. 29, fig. 4.

Length of hypotype, 0.40 mm. Rare in Sunset Bay tide pools. This species has been recorded from all the present oceans and as a fossil throughout most of the Tertiary.

Genus **Robertinoides** Höglund, 1947

Robertinoides (?) **charlottensis** (Cushman)

Plate 8, figure 6

Cassidulina charlottensis CUSHMAN, 1925, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 2, p. 41, pl. 6, figs. 6, 7.

Robertina charlottensis (CUSHMAN). CUSHMAN and F. L. PARKER, 1936, Contr. Cushman Lab. Foram. Res., vol. 12, pt. 4, p. 97, pl. 16, figs. 12a, b.

Robertina californica CUSHMAN and F. L. PARKER, 1936, *ibid.,* figs. 14a, b.

Robertinoides charlottensis (CUSHMAN). LOEBLICH and TAPPAN, 1953, Smithsonian Misc. Coll., vol. 121, no. 7, pp. 108-110, pl. 20, figs. 6, 7.

Length of hypotype, 0.65 mm.; breadth, 0.35 mm. Rare. According to Loeblich and Tappan (1953), the generic status of this species is in doubt because of possible misinterpretation by d'Orbigny of his material designated by him to be *Robertina.* The latter genus is characterized by a virguline aperture. Höglund (1947) described *Robertinoides* as having a double aperture. If d'Orbigny's illustration and description are proved to be inaccurate, the two generic names may be synonymous. In the Sunset Bay specimens the aperture is an L-shaped slit, running vertically into the face of the last chamber, and horizontally in the suture at the base of the chamber.

Genus **Angulogerina** Cushman, 1927

Angulogerina fluens Todd

Plate 8, figure 7

Angulogerina angulosa (WILLIAMSON). CUSHMAN, 1948 (not *Uvigerina angulosa* WILLIAMSON, 1858), Cushman Lab. Foram. Res., Spec. Publ. 23, p. 66, pl. 7, fig. 8.

Angulogerina fluens TODD, 1947, *in* CUSHMAN and TODD, Contr. Cushman Lab. Foram. Res., vol. 23, pt. 3, p. 67, pl. 16, figs. 6, 7.—CUSHMAN and Mc-

EXPLANATION OF PLATE 8

FIGS.		PAGE
1.	*Astrononion gallowayi* Loeblich and Tappan. × 60. a, side view; b, apertural view.	28
2.	*Elphidium* cf. *E. incertum* (Williamson). × 40. a, side view; b, apertural view.	28
3.	*E. subarcticum* Cushman. × 28. a, side view; b, apertural view.	28
4.	*Elphidiella nitida* Cushman. × 35. a, side view; b, apertural view.	28
5.	*Buliminella elegantissima* (d'Orbigny). × 70.	29
6.	*Robertinoides* (?) *charlottensis* (Cushman). × 30. a, dorsal view; b, apertural view.	29
7.	*Angulogerina fluens* Todd. × 60. a, side view; b, apertural view.	29
8.	*Discorbis columbiensis* Cushman. × 70. a, dorsal view; b, ventral view; c, edge view.	30
9, 10.	*D. ornatissima* Cushman. × 28. 9a, dorsal view; b, ventral view; c, edge view; 10a, b, ventral sides of a pair of individuals associated in plastogamy, showing young inside the excavated tests.	30
11.	*D. sanjuanensis* Cushman and Todd. × 18. a, dorsal view; b, ventral view; c, edge view.	30
12.	*Eponides columbiensis* (Cushman). × 18. a, dorsal view; b, ventral view; c, edge view.	30
13.	*Buccella inusitata* Andersen. × 28. a, dorsal view; b, ventral view; c, edge view.	30
14.	*Poroeponides lateralis* (Terquem). × 17. a, dorsal view; b, ventral view; c, apertural view.	30
15.	*Cassidulina limbata* Cushman and Hughes. × 32. a, ventral view; b, apertural view.	30
16.	*Cibicides lobulatus* (Walker and Jacob). × 34. a, dorsal view; b, ventral view; c, apertural view.	31
17.	*Planorbulina acervalis* H. B. Brady. × 25. a, dorsal view; b, ventral view; c, edge view.	31

CULLOCH, 1948, Allan Hancock Pacific Exped., vol. 6, no. 5, p. 288, pl. 36, fig. 1.—LOEBLICH and TAPPAN, 1953, Smithsonian Misc. Coll., vol. 121, no. 7, p. 112, pl. 20, figs. 10-12.

Length of hypotype, 0.45 mm.; breadth, 0.20 mm. Rare.

Family ROTALIIDAE

Genus **Discorbis** Lamarck, 1804

Discorbis columbiensis Cushman

Plate 8, figure 8

Discorbis columbiensis CUSHMAN, 1925, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 2, p. 43, pl. 6, fig. 13.—CUSHMAN and TODD, 1947, Cushman Lab. Foram. Res., Spec. Publ. 21, p. 20, pl. 3, figs. 14-16.

Diameter of hypotype, 0.32 mm.; thickness, 0.12 mm.; specimens range to 0.60 mm. in diameter. Common on eelgrass and algae in Sunset Bay tide pools.

Discorbis ornatissima Cushman

Plate 8, figures 9, 10

Discorbis ornatissima CUSHMAN, 1925, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 2, p. 42, pl. 6, figs. 11, 12.—CUSHMAN and TODD, 1947, Cushman Lab. Foram. Res., Spec. Publ. 21, p. 20, pl. 3, figs. 18, 19.

Diameter of hypotype, 0.70 mm.; thickness, 0.34 mm. One of the more common species in these collections. Many individuals occur in pairs, attached by their flat ventral sides. When separated, the individuals frequently show the ventral surfaces and internal chamber walls dissolved away, leaving cavities filled with numerous progeny, each composed of 2 chambers (Plate 8, fig. 10).

Discorbis sanjuanensis Cushman and Todd

Plate 8, figure 11

Discorbis sanjuanensis CUSHMAN and TODD, 1947, Cushman Lab. Foram. Res., Spec. Publ. 21, p. 21, pl. 3, fig. 21.

Diameter of hypotype, 0.85 mm.; thickness, 0.20 mm. Rather rare in Sunset Bay tide pools. Very common in region of San Juan Islands, Washington (Cushman and Todd, 1947).

Genus **Eponides** Montfort 1808

Eponides columbiensis (Cushman)

Plate 8, figure 12

Pulvinulina columbiensis CUSHMAN, 1925, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 2, p. 43, pl. 7, fig. 1.

Eponides columbiensis (CUSHMAN). CUSHMAN and TODD, 1947, Cushman Lab. Foram. Res., Spec. Publ. 21, p. 22, pl. 4, fig. 1.

Diameter of hypotype, 1.15 mm.; thickness, 0.67 mm. This is one of the most numerous and striking species in these tide pool collections.

Genus **Buccella** Andersen, 1952

Buccella inusitata Andersen

Plate 8, figure 13

Eponides frigidus (CUSHMAN). CUSHMAN and TODD, 1947 (not *Pulvinulina frigida* CUSHMAN, 1922), Cushman Lab. Foram. Res., Spec. Publ. 21, pl. 3, fig. 20.—CUSHMAN, 1948, *ibid.*, no. 23, p. 71, pl. 8, fig. 7.

Buccella inusitata ANDERSEN, 1952, Journ. Washington Acad. Sci., vol. 42, no. 5, p. 148, figs. 10-11.—LOEBLICH and TAPPAN, 1953, Smithsonian Misc. Coll., vol. 121, no. 7, p. 116, pl. 22, fig. 1.

Diameter of hypotype, 0.50 mm.; thickness, 0.27 mm. Rather common in tide pools at Sunset Bay.

Genus **Poroeponides** Cushman, 1944

Poroeponides lateralis (Terquem)

Plate 8, figure 14

Rosalina lateralis TERQUEM, 1878, Mém. Soc. Géol. France, sér. 3, vol. 1, Mém. 3, p. 25, pl. 2, fig. 11.

Pulvinulina lateralis (TERQUEM). H. B. BRADY, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 689, pl. 106, figs. 2, 3.

Eponides lateralis (TERQUEM). CUSHMAN, 1931, Bull. 104, U. S. Nat. Mus., pt. 8, p. 47, pl. 10, fig. 5.

Poroeponides lateralis (TERQUEM). CUSHMAN, 1944, Cushman Lab. Foram. Res., Spec. Publ. 12, p. 34, pl. 4, fig. 23.—F. L. PARKER, 1948, Bull. Mus. Comp. Zool., Harvard, vol. 100, no. 2, pl. 1, figs. 17a, b.

Length of hypotype, 1.20 mm.; breadth, 0.76 mm.; thickness, 0.55 mm. The figured specimen is the only individual of this species found in the collections from Sunset Bay. It is so unmistakable that it was included in this study. This species is common in tropical and subtropical waters, and very abundant off the south coast of New England where the influence of the Gulf Stream is marked (Cushman, 1931). Cushman (1944) records this species from European waters. The type is from the Pliocene of the Isle of Rhodes.

Family CASSIDULINIDAE

Genus **Cassidulina** d'Orbigny, 1826

Cassidulina limbata Cushman and Hughes

Plate 8, figure 15

Cassidulina laevigata BAGG, 1912 (not D'ORBIGNY), U. S. Geol. Surv., Bull. 513, p. 43.

Cassidulina limbata CUSHMAN and HUGHES, 1925, Contr. Cushman Lab. Foram. Res., vol. 1, no. 5, p. 12, pl. 2, figs. 2a-c.—CUSHMAN, 1927, Bull. Scripps Instit. Oceanography, Tech. Ser., vol. 1, no. 10, p. 166, pl. 6, fig. 4.—CUSHMAN and GRAY, 1946, Cushman Lab. Foram. Res., Spec. Publ. 19, p. 42, pl. 7, figs. 14-16.

Diameter of hypotype, 0.55 mm.; thickness, 0.30 mm. Fairly common in tide pool material. Very abundant in the Pliocene of California (Cushman and Hughes, 1925).

Family ANOMALINIDAE

Genus **Cibicides** Montfort, 1808

Cibicides lobulatus (Walker and Jacob)

Plate 8, figure 16

(For earlier references, *see* CUSHMAN, 1931, Bull. 104, U. S. Nat. Mus., pt. 8, p. 118, pl. 21, fig. 3.)—CUSHMAN, 1944, Cushman Lab. Foram. Res., Spec. Publ. 12, p. 36, pl. 4, figs. 27, 28.—CUSHMAN and GRAY, 1946, *ibid.*, no. 19, p. 45, pl. 8, fig. 14.—CUSHMAN, 1948, *ibid.*, no. 23, p. 78, pl. 8, fig. 14.

Diameter of hypotype, 0.50 mm.; thickness, 0.11 mm. Common, attached to eelgrass and algae in tide pools. This species has a wide range, both as a living and as a fossil form. In life it has a pinkish color.

Family PLANORBULINIDAE

Genus **Planorbulina** d'Orbigny, 1826

Planorbulina acervalis H. B. Brady

Plate 8, figure 17

Planorbulina acervalis H. B. BRADY, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 657, pl. 92, fig. 4.—CUSHMAN, 1915, Bull. 71, U. S. Nat. Mus., pt. 5, p. 29, pl. 14, fig. 1.—CUSHMAN, 1931, Bull. U. S. Nat. Mus., pt. 8, p. 130, pl. 25, fig. 1.—CUSHMAN and GRAY, 1946, Cushman Lab. Foram. Res., Spec. Publ. 19, p. 46, pl. 8, fig. 20.

Diameter of hypotype, 0.85 mm. Rare in Sunset Bay tide pools.

LITERATURE CITED

CUSHMAN, J. A., (1918-1931), The Foraminifera of the Atlantic Ocean: Bull. 104, U. S. Nat. Mus., pts. 1-8, 1064 pp.

———, (1944), Foraminifera from the shallow water of the New England coast: Cushman Lab. Foram. Res., Spec. Publ. 12, 37 pp.

———, (1948), Arctic Foraminifera: *Ibid.*, Spec. Publ. 23, 79 pp.

——— and GRAY, H. B., (1946), A foraminiferal fauna from the Pliocene of Timms Point, California: *Ibid.*, Spec. Publ. 19, 46 pp.

——— and HUGHES, D. D., (1925), Some later Tertiary Cassidulinas of California: *Ibid.*, Contr., vol. 1, pp. 11-16.

——— and MCCULLOCH, I., (1939), A report on some arenaceous Foraminifera: Allan Hancock Pacific Exped., vol. 6, no. 1, 113 pp.

——— and ———, (1940), Some Nonionidae in the collections of the Allan Hancock Foundation: *Ibid.*, no. 3, pp. 145-178.

———, STEWART, R. E., and K. C., (1947), Five papers on Foraminifera from the Tertiary of western Oregon: Oregon Dept. Geol. and Mineral Industries, Bull. 36, parts I-V, 111 pp. (1949), Parts VI-VIII, pp. 113-208.

——— and TODD, R., (1947), Foraminifera from the coast of Washington: Cushman Lab. Foram. Res., Spec. Publ. 21, 23 pp.

DETLING, M. R., (1946), Foraminifera of the Coos Bay lower Tertiary, Coos County, Oregon: Journ. Paleontology, vol. 20, no. 4, pp. 348-361.

HÖGLUND, H., (1947), Foraminifera in the Gullmar Fjord and the Skagerak: Zool. Bidrag Uppsala, vol. 26, 328 pp.

LOEBLICH, A. R., and TAPPAN, H., (1953), Studies of Arctic Foraminifera: Smithsonian Misc. Coll., vol. 121, no. 7, 150 pp.

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180. THE TAXONOMIC STATUS OF *PALMERINELLA PALMERAE* BERMUDEZ

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ABSTRACT

The structure of **Palmerinella** is analyzed and its relationship to **Ceratobulimina** is suggested.

DISCUSSION

Specimens of *Palmerinella palmerae* Bermudez, the type species of *Palmerinella,* collected from 2-5 fms. off Havana, Cuba, were sent to me by Dr. Bermudez.

A study of the specimens reveals that the taxonomic status of this species and also of the genus have been much misunderstood. Bermudez (1934, p. 83, text figs. 1-3) established the genus and described this species. Later (Bermudez, 1952) he placed it in the subfamily Planulininae. Cushman (1950, p. 33) also considered that it was related to *Planulina.*

The planispiral test is composed of clear calcium carbonate having very large pores not only on the sides of the chambers but also on the periphery. The sutures are distinct, very slightly depressed, and slanting. The periphery is rounded. The chambers are slightly involute, leaving the umbilical area free, this area being filled with clear material perforated by some large pores. The chambers are narrow with about 12-14 in the adult test in the last formed whorl.

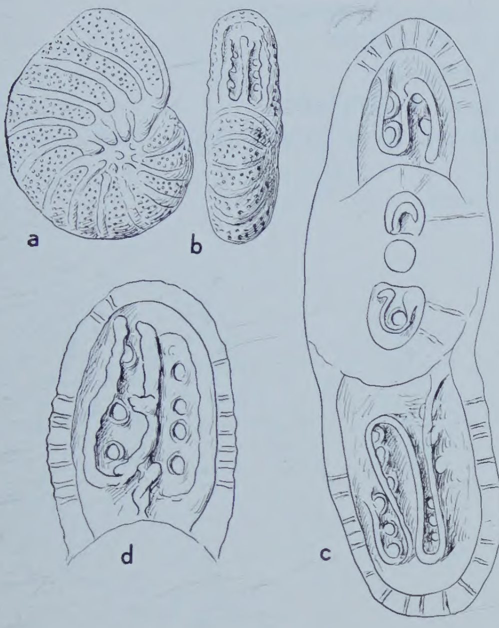
The lumen of each chamber is divided into several parts by a very characteristic toothplate which borders the originally loop-shaped aperture, extends along this aperture (which later is almost closed) around the upper border and then down again along the opposite border. Then it again extends upward towards the periphery where it ends. Thus, near the base of each apertural face a sling of clear poreless material is found, growing up from each proximal septum and ending in a fringed thin lamellum at one side of the chamber, whereas it forms near to the peripheral part of each chamber a rounded part, forming the second sling. At the base of this doubling plate openings occur which pass into each former chamber; these openings piercing thus the septal part are bordered with a thickened rim. Since each complicated toothplate near to the axial part of each chamber forms a sling also, and since this sling connects with a part of the septal wall underneath which runs upward, in a longitudinal section of the test we find at the axial part of each chamber that upward bending part of the toothplate, forming something like a secondary chamberlet in that section near to the wall of a former whorl.

In the earlier whorls, surrounding the proloculus, the toothplate is much more primitively built, being here only a simple rounded toothplate running from the base of each chamber over the peripheral part of the single septal opening, the former aperture; this structure is strongly reminiscent of what has been found in the genus *Ceratobulimina* (Hofker, 1951, p. 318-319, text figs. 215-217). In *Ceratobulimina* toothplates may form more complicated slings very much resembling those found here in *Palmerinella.*

These structures clearly show that *Palmerinella* is not closely related to *Planulina* but forms one of the end forms of development in the Ceratobuliminidae.

Ceratobulimina itself shows very fine pores, whereas *Palmerinella* has distinct and rather coarse pores; but they are protopores as well. Such an increase of porediameter during the development of a group of Foraminifera is well known. We find this phenomenon in the development of the *Globigerina*-group, where all older forms and also the more primitively built forms show fine pores, whereas the more developed species increasingly show coarser pores, especially during the development in the Tertiary. In groups in which toothplates have developed, in the ancient forms these toothplates are of a simple type, whereas in the more advanced and later forms they become complicated.

Another striking instance is found in *Bolivina* where the Jurassic forms have very fine pores and a simple toothplate. In addition they have aragonite tests. During the Cretaceous this primitive form continues but in the Tertiary the pores may become rather coarse, except in the initial chamber, and the toothplates and apertures become more complicated. In the genus *Reussella* all Cretaceous species show very fine pores, simple apertures and toothplates but in the later Tertiary the pores become coarse and the toothplates and apertures develop into very complicated structures. In the Siphoninidae also a similar development occurs. In primitive *Pulsiphonina* and in *Siphoninella* the pores are fine but in *Siphonina* they gradually become coarse. In addition the apertures, which are simple in *Pulsiphonina,* are more complicated. In each species of the genus *Gavelinella* the pores gradually increase in size with time but they all start with



TEXT FIGURES A-E

Palmerinella palmerae Bermudez. a, whole test, side view. × 57. b, test with broken end-chamber, apertural face. × 57. c, transverse section, showing proloculus, first chambers with primitive toothplates, and later chambers with complicated toothplates and multiple apertures (septal openings). × 160. d, part of section of chamber, showing toothplate and multiple septal openings. × 160. e, part of longitudinal (horizontal) section, with the toothplates in the chambers and the folding axial parts of the toothplates, suggesting secondary chamberlets. × 160.

very fine ones (Hofker, 1957, p. 371, fig. 424). In the final development of the group (youngest Cretaceous and Tertiary) the tests become planispiral and the pores are rather coarse even in the early stages of a species (*Gavelinonion*). *Palmerinella* also is an instance of this rule of development. The tests in *Ceratobulimina* are always brownish and are built of aragonitic material contrarily to those of *Palmerinella*. In *Ceratobulimina* the pores are fine, in *Palmerinella* coarse. In the oldest forms of *Ceratobulimina* the toothplates are simple and then gradually become more complicated until the highly developed toothplate of *Palmerinella* is reached. In addition, the tests of *Ceratobulimina* are trochoid while those of *Palmerinella* are planispiral. A similar development is seen in the Epistomariidae where the primitive forms have simple toothplates and fine pores while the test is typically aragonitic. In *Epistomaria* the toothplate has become much more complicated, the apertural characters much more highly developed, and the pores rather coarse. In addition, the walls are almost completely calcareous (Hofker, 1953, p. 135, fig. 4).

REFERENCES

Bermudez, P. J., 1934, Un género y especie nueva de foraminíferos vivientes de Cuba: Mem. Soc. Cubana Hist. Nat., vol. 8, no. 2, pp. 83-86.

———, 1952, Estudio sistematico de los foraminíferos rotaliformes: Min. de Minas e Hydrocarburos, Bol. Geol., vol. 2, no. 4, 230 pp.

Cushman, J. A., 1950, Foraminifera, their classification and economic use: Ed. 4 (2nd printing), Harvard Univ. Press., 605 pp.

Hofker, J., 1951, The Foraminifera of the Siboga Expedition: Part III: Siboga Exped. Mon. IVa, 513 pp.

———, 1953, The genus *Epistomaria* Galloway, 1933 and the genus *Epistomarioides* Uchio, 1952: Paläont. Zeit., vol. 27, pp. 129-142.

———, 1957, Foraminiferen der Oberkreide von Nordwestdeutschland und Holland: Beihefte Geol. Jahrb., vol. 27, 464 pp.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME IX, PART 2, APRIL, 1958

181. THE TAXONOMIC POSITION OF THE GENUS *COLOMIA* CUSHMAN AND BERMUDEZ, 1948

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ABSTRACT

The structure of **Colomia** is discussed and its relationship to **Conorboides** suggested.

DISCUSSION

Cushman and Bermudez (1948, p. 12) established the genus *Colomia* for typical sugar-loaf-like tests which occur in the lower Maestrichtian of central Europe and America. Their description (Cushman, 1950, p. 265) is as follows:

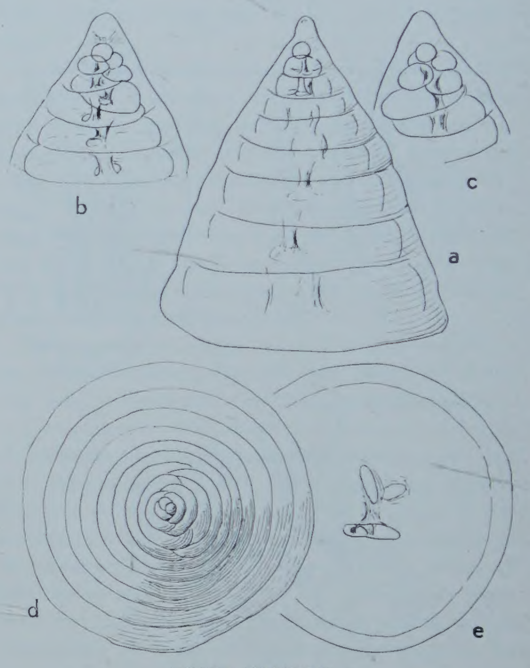
"Test conical; earliest chambers indistinct, later ones uniserial, circular in transverse section, interior with vertical columns or tubular structures connecting walls of adjacent chambers; wall calcareous, perforate; aperture in the adult terminal, a slightly arcuate, narrow opening in the middle of the apertural face."

Cushman placed this genus in the Buliminidae and supposed it to be closely related to *Ungulatella*.

In the description the first chambers are mentioned as indistinct but in a clarifier they are readily distinguished. In the microspheric generation a small proloculus is followed by a set of three chambers which in shape very closely resemble those of *Conorboides mitra* (Hofker) and other species of the genus *Conorboides*. A set of two chambers follows usually followed in turn by a second set of two chambers in one whorl; the following chamber is the first uniserial one.

In the trochoid part of the microspheric test the apertures are those of *Conorboides*, with the typical toothplate. In the uniserial chambers the aperture becomes terminal, areal, and slit-like, in the middle of the basal wall. Each successive aperture forms an angle of about 80° with the preceding one, indicating that though the chambers are uniserial their arrangement in respect to the axis of the test is that of a trochoidly coiled test with about 4-5 chambers in a whorl. Two adjacent walls are connected by the toothplate, the tubular structure mentioned in the description, and this toothplate has its ventral edge attached to one of the long sides of the aperture while its free-folded part crosses the axis of the aperture. The diameter of the proloculus of the microspheric tests is 12-14μ.

In the megalospheric generation the test begins with a large proloculus having a diameter of about 40μ, followed by a whorl of two chambers. These chambers

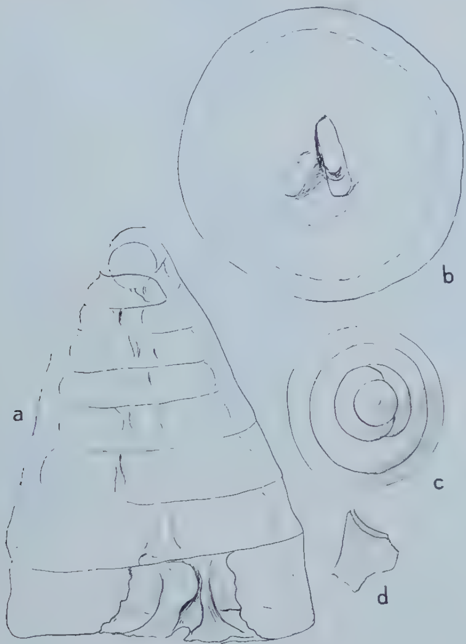


TEXT FIGURE 1

Colomia cretacea Cushman, microspheric specimen. × 160. a. Complete test showing triserial and biserial sets of chambers with toothplates near axis of test, followed by uniserial chambers with toothplates in center. Optical section. b. Part of the same test, turned 90° in respect to a. c. Same test, turned 90° in respect to b. d. Same test, from above, showing the arrangement of chambers. e. Same test, apertural view, aperture with two septal foramina (former apertures) seen below, to demonstrate the arrangement of the uniserial chambers in a whorl of nearly 5 chambers.

show the usual conorboid aperture and toothplate at the axis of the test. The uniserial set of chambers follows. In these chambers the septal foramina and toothplates are arranged at angles of about 65°, thus point to an original coiling of about five chambers in a whorl.

The walls of the test show the peculiar brownish color of typical *Conorboides*, *Höglundina* and *Ceratobulimina* (aragonitic tests) and not the white or hyaline texture of the walls of the Buliminidae (calcareous tests). In the outer walls very fine pores are found,



TEXT FIGURE 2

Colomia cretacea Cushman, megalospheric specimen from the same sample. × 160. a. Complete test from the side, in oil, showing the proloculus, the toothplates; in the last-formed chamber part of the wall is removed to show the foramen and the toothplate surrounding it. b. Basal view, with last-formed aperture and the foramen of the former chamber, making an angle with the last-formed aperture. c. Initial side, showing the proloculus, two trochoidal chambers and some uniserial chambers. d. Part of test wall, with the densely placed fine pores.

as in *Conorboides* and related genera. With polarized light the tests of *Conorboides* and *Colomia* show identical features. All these characteristics definitely point to a relationship with *Conorboides* and not to *Bulimina*.

Conorboides mitra was described from the lower Cretaceous. In this species the first part of the test (Hofker, 1951) shows 5 chambers in a whorl, but adult specimens have a somewhat dome-shaped test with only two chambers in a whorl. The aperture remains axial. *Colomia* thus is merely a more advanced *Conorboides* in which the biserial chambers have become uniserially arranged. This arrangement always goes hand in hand with the formation of areal apertures, as in *Rectobolivina*.

The description and figures given here are drawn from specimens of *Colomia cretacea* Cushman from the lower Maestrichtian of Gerhardsreuter Graben near Siegsdorf, Bavaria, Germany. They were kindly sent to me by H. Hagn.

Egger (1899, p. 29, pl. 14, fig. 29) described this species from the Gerhardsreuter Schichten near Starzmühle as *Textularia turris* ? with the following characteristics: "0,25-0,50 mm.; Zuckerhut; kleine Anfangskammer; die Kammern breiten sich gegen dem Rand rundlich aus; Rand der Schale schliesst mit der letzten Kammer kantig ab; zarte Horizontalleisten; Mündung Querspalt in der Endobersläche."

Cushman found this species in the Upper Cretaceous of Havana, Cuba. Bandy (1951, p. 512, pl. 75, figs. 11, 12) described a similar species, *Colomia californica*, with slightly different characteristics from the Upper Cretaceous of the Carlsbad area in California. He also mentions the triserial early chambers.

REFERENCES

Bandy, O. L., 1951, Upper Cretaceous Foraminifera from the Carlsbad area, San Diego County, California: Journ. Pal., vol. 25, no. 4, pp. 488-513.

Cushman, J. A., 1950, Foraminifera, their classification and economic use, ed. 4 (2nd printing), Harvard University Press, 605 pp.

——— and Bermudez, P. J., 1948, *Colomia*, a new genus from the Upper Cretaceous of Cuba: Contr. Cushman Lab. Foram. Res., vol. 24, pt. 1, pp. 12, 13.

Egger, J. G., 1899, Foraminiferen und Ostrakoden aus den Kreidemergeln der Oberbayerischen Alpen: Abh. k. bayer. Akad. Wiss., II Cl., vol. 21, 230 pp.

Hofker, J., 1951, The Foraminifera of the Siboga Expedition: Part. III: Siboga exped., Mon. IVa, 513 pp.

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VOLUME IX, PART 2, APRIL, 1958

182. RHIZOPODA FROM THE SALTON SEA, CALIFORNIA

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ABSTRACT

The rhizopod fauna of the Salton Sea contains twenty foraminiferal species, four of which are new, and three species of Thecamoebina. All species are illustrated and the new ones are named and described.

INTRODUCTION

The writer recently completed a detailed environmental study of the Salton Sea; the results and conclusions of this investigation will be published shortly in another periodical. However, in order to make the data immediately available to students of Rhizopoda, the location of the stations where collections were made (Figure 1) and the frequency distribution of the species (Appendix) are given in this paper.

During the field work, samples of approximately 500 grams of bottom sediment were collected. In order to detect living specimens the samples were preserved in isopropyl alcohol at the time of collection and later stained with an organic dye (rose Bengal) as outlined in the procedure specified by Walton (1952). The samples were then weighed and washed with a 250-mesh screen (opening 0.062 millimeter) to eliminate the clay fraction of the sediment. After washing, the silt and sand fractions were dried and treated with carbon tetrachloride to float the Rhizopoda which were then filed in vials for later study. Residues from the floatation were discarded as they contained only a few tests filled with fine-grained sediment.

Representative splits of the concentrates, large enough to fill a counting slide, were obtained by using a microsplitter of a modified Otto (1933) type. Frequency counts of 150 to 400 individuals, including living and dead specimens, were made for each sample. In a few samples, when specimens were rare, less than 150 individuals were counted. During the counting the number of specimens of each species was recorded and later computed as percentage of the total number of Foraminifera in the sample. Species of Thecamoebina were not included as they are restricted to fresh water (Stations 1, 2, 3 on the Alamo River). The percentage values are given in the appendix. This method was used because it is the most accurate presentation for comparison with similar studies by other investigators. The foraminiferal number (i.e. number of Foraminifera per gram of sediment) was computed in order to permit correlation of the total number of Foraminifera present in samples of comparable size.

The foraminiferal number, F. N., was obtained in the following manner: the foraminiferal sample was split evenly until a fraction containing about 500 specimens was obtained; care was taken to note the number of splits. The exact number of individuals in the last split was then counted and the foraminiferal number was obtained by the formula:

$$\text{F. N.} = \frac{\text{Number of specimens counted x } 2^n}{\text{Weight in grams of sediment in the sample}}$$

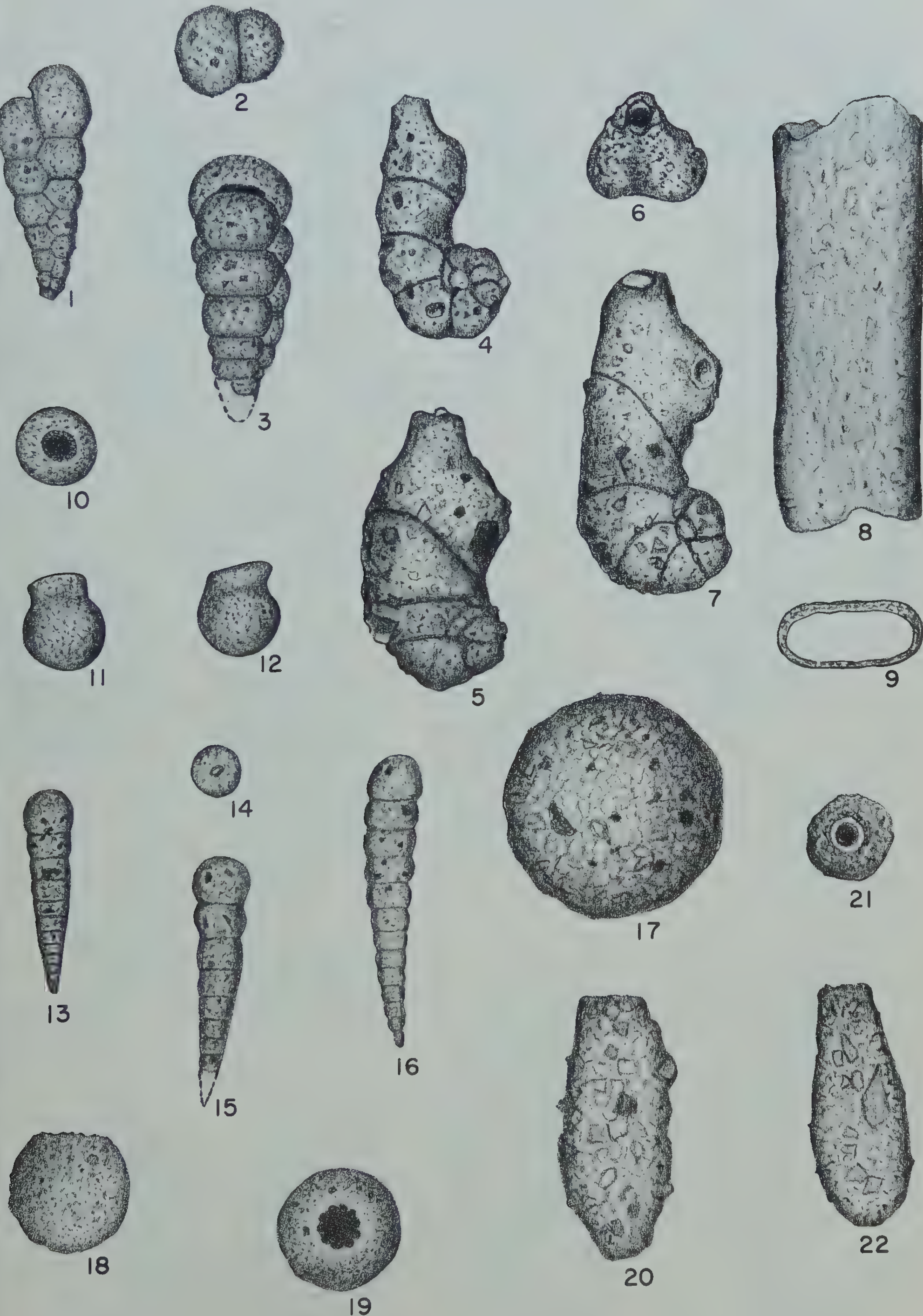
(In the formula the exponent n represents the number of splits)

A total of 103 bottom samples was collected and treated as explained in the preceding paragraphs.

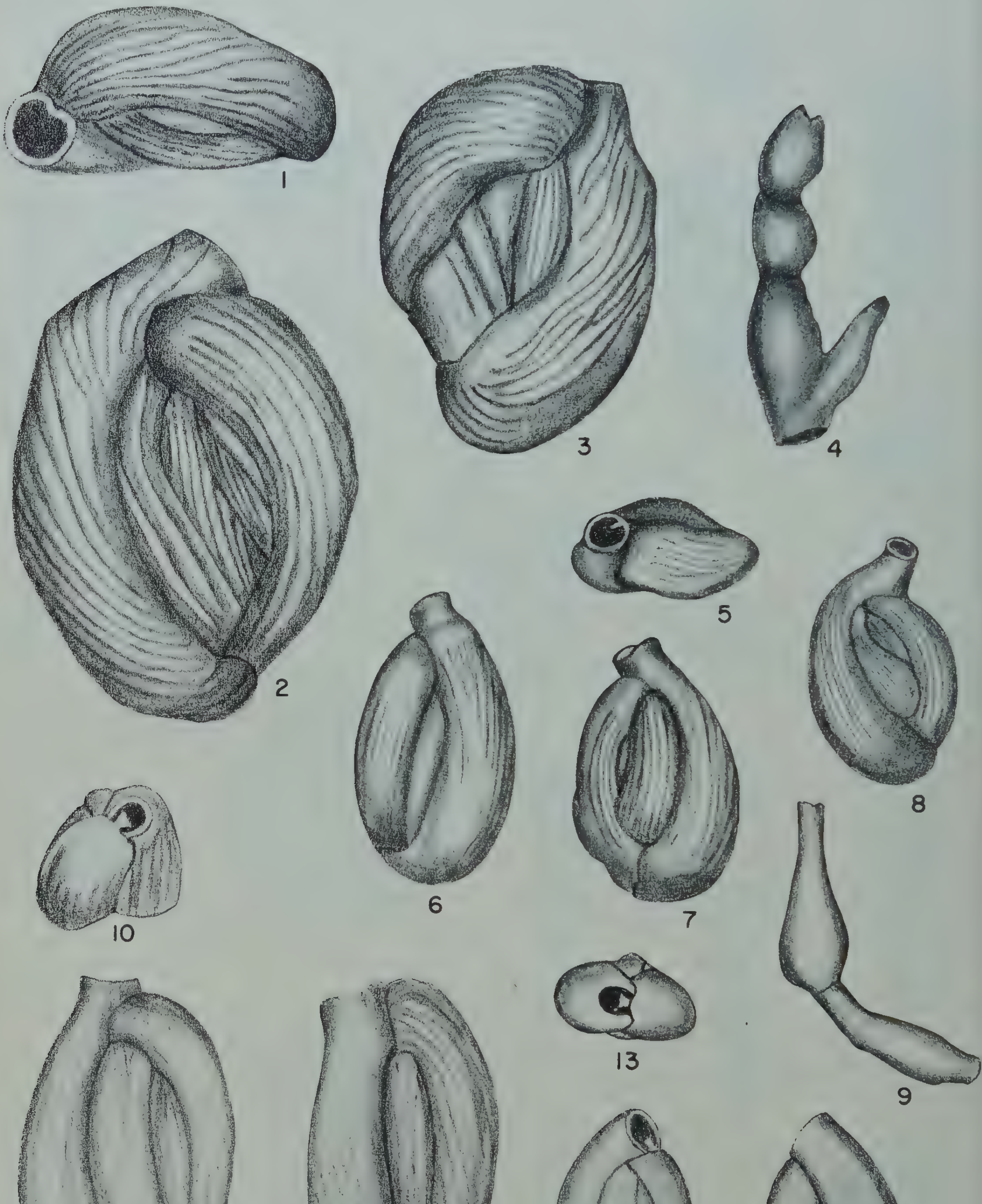
Research and library facilities were provided by the

EXPLANATION OF PLATE 9

Figs.		Page
	FORAMINIFERA	
1, 2, 3.	*Textularia earlandi* Parker, × 124; 1, side view, hypotype, USC No. 4618; 2, apertural view; 3, side view, hypotype, USC No. 4619.	41
4, 5, 6, 7.	*Ammobaculites salsus* Cushman and Bronnimann, × 124; 4, side view, hypotype, USC No. 4584; 5, side view, hypotype, USC No. 4585; 6, apertural view; 7, side view, hypotype, USC No. 4586.	37
8, 9.	*Bathysiphon* sp., × 42; 8, side view; 9, apertural view, hypotype, USC No. 4587.	37
13, 14, 15, 16.	*Reophax nana* Rhumbler, × 124; 13, side view, hypotype, USC No. 4609; 14, apertural view; 15, side view, hypotype, USC No. 4610; 16, side view, hypotype, USC No. 4611.	40
17.	*Saccammina sphaerica* Sars, × 124; hypotype, USC No. 4612.	40
	THECAMOEBINA	
10, 11, 12.	*Difflugia urceolata* Carter, × 124; 10, apertural view; 11, side view, hypotype, USC No. 4596; 12, side view, hypotype, USC No. 4597.	41
18, 19.	*Pseudodifflugia gracilis* Schlumberger, × 124; 18, side view; 19, apertural view, hypotype, USC No. 4621.	42
20, 21, 22.	*Difflugia oblonga* Ehrenberg, × 124; 20, side view, hypotype, USC No. 4602; 21, apertural view; 22, side view, hypotype, USC No. 4603.	41



ARNAL: SALTON SEA RHIZOPODA



ARNAL: SALTON SEA RHIZOPODA

Allan Hancock Foundation at the University of Southern California. Thanks are given to the Western Gulf Oil Company for permission to publish the manuscript.

SYSTEMATICS

The following is an alphabetized reference list of the living and fossil species of Foraminifera and Thecamoebina encountered in Salton Sea sediments. Usually, the original and one subsequent reference are given for each species which has been described previously. Included are the descriptions of three new species and a new variety. The illustrations were drawn by the author. The type specimens are deposited in the paleontological collections at the University of Southern California.

FORAMINIFERA

Ammobaculites salsus Cushman and Bronnimann

Plate 9, figures 4, 5, 6, 7

1948. *Ammobaculites salsus* Cushman and Bronnimann, Contrib. Cushman Lab. Foram. Research, vol. 24, pt. 1, p. 16, pl. 3, figs. 7-9.

1953. *Ammobaculites salsus* Parker, Phleger and Peirson, Cushman Foundation Foram. Research, Special Pub. 2, p. 5, pl. 1, figs. 17-25.

This species was originally described from inshore mud, brackish water, Mangrove swamp, Trinidad, B.W.I. It has also been reported by Parker *et al.* from bay and marsh facies in the San Antonio region, Texas. It occurs only in shallow water along the coast of the Salton Sea. Living and dead specimens were recorded.

Hypotypes.—USC Nos. 4584, 4585, 4586.

Bathysiphon sp.

Plate 9, figures 8, 9

This species resembles *B. arenacea*, but the wall is much thinner. One dead specimen was found in the delta of New River. Length of specimen, 1.85 mm.; width, 0.60 mm.

Hypotype.—USC No. 4587.

Bolivina striatula Cushman

Plate 11, figures 13, 14, 15, 16

1922. *Bolivina striatula* Cushman, Carnegie Inst. Washington Pub. 311, p. 27, pl. 3, fig. 10.

1953. *Bolivina striatula*, Parker, Phleger and Peirson, Cushman Foundation Foram. Research, Special Pub. 2, p. 6, pl. 4, figs. 4, 5.

This species was originally described from shallow water of the Tortugas region, Florida. Bandy (1954) reported it from shallow water of the Gulf of Mexico. Parker *et al.* also mentioned the presence of that species in their open gulf shallow water facies. In the Salton Sea it occurs with high percentages in fairly "deep" water (30 feet). Both living and dead specimens are abundant.

Hypotypes.—USC Nos. 4588, 4589.

Buliminella elegantissima (d'Orbigny)

Plate 11, figures 7, 8, 9

1839. *Bulimina elegantissima* d'Orbigny, Voy. Amér. Mérid., vol. 5, pt. 5, "Foraminifères," p. 51, pl. 7, figs. 13, 14.

1953. *Buliminella elegantissima* Bandy, Journal Paleont., vol. 27, p. 176, figs. 14a, b.

This species was originally described from the southwestern coast of South America, from recent coastal sands. It is widespread in shallow water. The Salton Sea specimens appear to be smaller than usual. Large populations occur where there is a great abundance of nutrients. Living and dead specimens are very common.

Hypotypes.—USC Nos. 4590, 4591.

Calcituba simplex Arnal, n. sp.

Plate 10, figures 4, 9

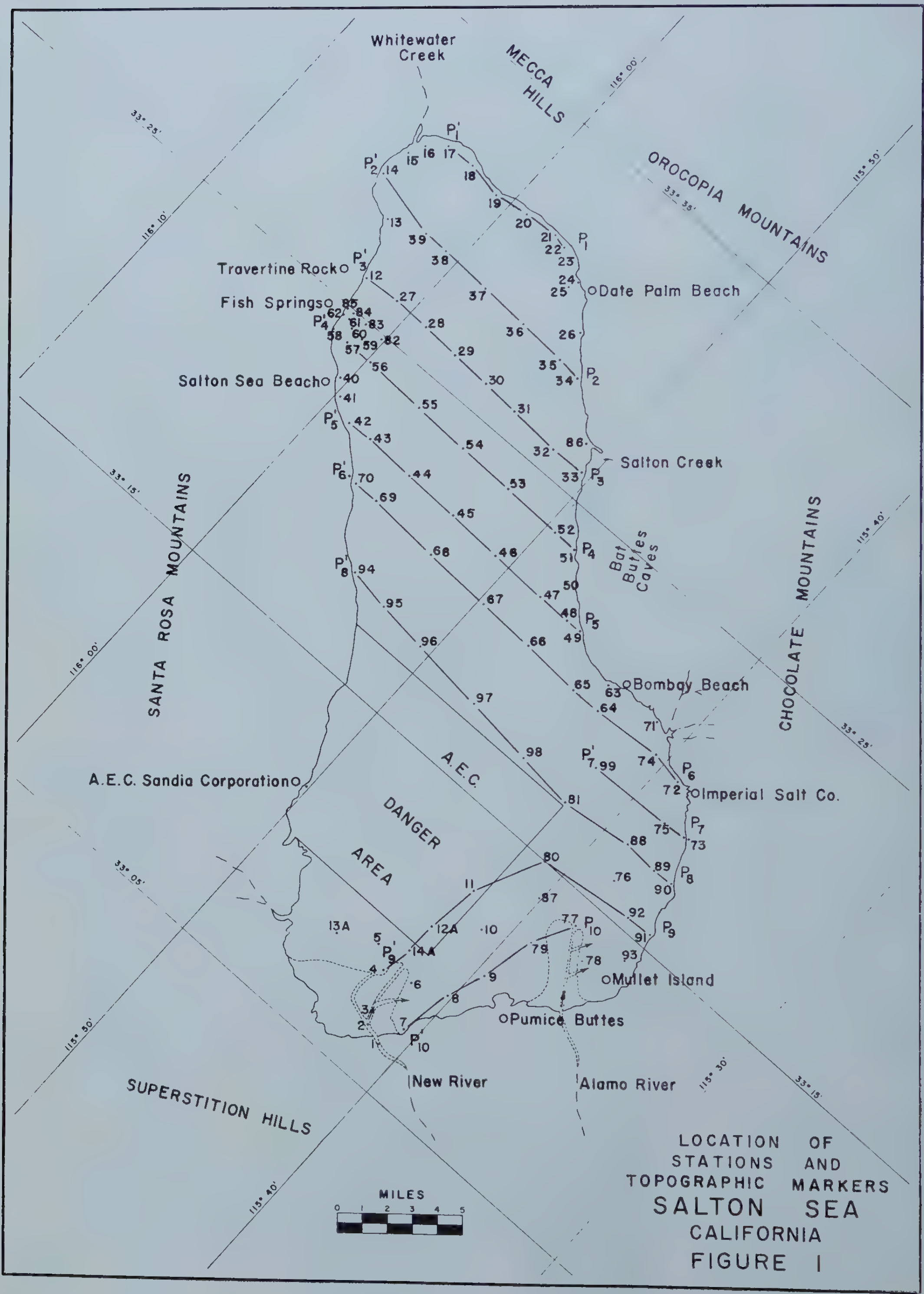
Test, a simple tube, irregular in diameter, more or less curvilinear, seldom branching; wall, calcareous imperforate; apertures, simple round openings at the ends of the branches. Length of specimens may vary from 0.30 to 1 mm.

There is a large amount of variation in the shape of the test; however, it remains simple as compared to the type species, *Calcituba polymorpha* Roboz (1884), hence the specific name. This species has been found living at intermediate depths in the Salton Sea (15 to 40 feet).

Holotype.—USC No. 4592. *Paratype.*—USC No. 4593.

EXPLANATION OF PLATE 10

Figs.	Foraminifera	Page
1, 2, 3.	*Massilina protea* Parker, × 124; 1, apertural view; 2, side view, hypotype, USC No. 4598; 3, side view, hypotype, USC No. 4601.	39
4, 9.	*Calcituba simplex* Arnal, n. sp., × 124; 4, holotype, USC No. 4592; 9, paratype, USC No. 4593.	37
5, 6, 7, 8.	*Quinqueloculina rhodiensis* Parker var. *incondita* Arnal, n. var., × 124; 5, apertural view; 6, side view; 7, side view, holotype, USC No. 4606; 8, side view, paratype, USC No. 4607.	39
10, 11, 12.	*Quinqueloculina rhodiensis* Parker, × 124; 10, apertural view; 11, side view; 12, side view, hypotype, USC No. 4605.	39
13, 14, 15.	*Quinqueloculina bellatula* Bandy, × 124; 13, apertural view; 14, side view; 15, side view, hypotype, USC No. 4604.	39



LOCATION OF STATIONS AND TOPOGRAPHIC MARKERS
SALTON SEA
CALIFORNIA
FIGURE 1

Elphidium gunteri Cole

Plate 12, figures 9, 10

1931. *Elphidium gunteri* Cole, Florida State Geol. Survey Bull. 6, p. 34, pl. 4, figs. 9, 10.
1953. *Elphidium gunteri* Parker, Phleger and Peirson, Cushman Foundation Foram. Research, Special Pub. 2, p. 8, pl. 3, figs. 18, 19.

This species was originally described from a Pliocene marl from Florida. No living individual was found in the Salton Sea; the specimens found in the sediments are reworked from nearby outcrops of the Borrego formation, of which this species is one of the faunal elements.

Hypotype.—USC No. 4594.

Elphidium tumidum Natland

Plate 12, figures 7, 8

1938. *Elphidium tumidum* Natland, Bull. Scripps Inst. Ocean. Tech. Ser., vol. 4, no. 5, p. 144, pl. 5, figs. 5, 6.
1955. *Elphidium tumidum* Walton, Journal Paleont., vol. 29, p. 1007, pl. 101, figs. 8, 9.

Living and dead specimens of this species were found at many stations and in great abundance along the coasts of the Salton Sea. Walton recorded it from a marsh on the coast of Baja California and also in shallow littoral waters. The species was originally described from shallow depth (10 meters) in Avalon Bay, Santa Catalina Island, Southern California.

Hypotype.—USC No. 4595.

Massilina protea Parker

Plate 10, figures 1, 2, 3

1953. *Massilina protea* Parker, *in* Parker, Phleger and Peirson, Cushman Foundation Foram. Research, Special Pub. 2, p. 10, pl. 2, figs. 1 to 4, and text p. 10, fig. 2.

This very irregular and variable species was originally described from marsh and bay stations in the San Antonio region, Texas. In the Salton Sea, it occurs in very low percentage in stations along the coast. Living and dead specimens were observed.

Hypotypes.—USC Nos. 4598, 4601.

Nonion saltonensis Arnal, n. sp.

Plate 12, figures 11, 12, 13

Test small for the genus, planispiral with a tendency to be evolute; periphery lobulate; umbilical region large and slightly depressed; chambers globular, increasing very slightly but very regularly as added, 8 to 11 chambers in the last whorl, chambers of the previous whorl showing slightly in well preserved specimens; sutures radial depressed, not limbate; wall smooth, very finely perforate; aperture a very low arched opening at the base of the last septal face, visible only under water. Diameter, 0.15 to 0.30 mm.; thickness, 0.06 to 0.10 mm.

This species is similar to *Noniona exponens* Brady, Parker and Jones (1888) but differs in having a lobulate periphery and more globular chambers. It is one of the species of the Borrego formation. Specimens found in the Salton Sea are reworked.

Holotype.—USC No. 4599. *Paratype.*—USC No. 4600.

Quinqueloculina bellatula Bandy

Plate 10, figures 13, 14, 15

1950. *Quinqueloculina akneriana* d'Orbigny var. *bellatula* Bandy, Journal Paleont., vol. 24, p. 273, pl. 41, figs. 1a-c.

This species was originally recorded from the Pleistocene sediments of Cape Blanco, Oregon. It is living and abundant in shallow water of the Salton Sea at most of the stations.

Hypotype.—USC No. 4604.

Quinqueloculina rhodiensis Parker

Plate 10, figures 10, 11, 12

1826. *Quinqueloculina costata* d'Orbigny (*nomen nudum*), Ann. Sci. Nat., vol. 7, p. 301, no. 3.
1953. *Quinqueloculina rhodiensis* Parker, *in* Parker, Phleger and Peirson, Cushman Foundation Foram. Research, Special Pub. 2, p. 12, pl. 2, figs. 15-17.

This species was originally described as Recent from the Mediterranean Sea. Parker *et al.* found it in the marshes of the Rockport area near San Antonio, Texas. It is fairly widespread in the shallow waters of the Salton Sea, where it represents always small percentages. Living and dead specimens were observed.

Hypotype.—USC No. 4605.

Quinqueloculina rhodiensis Parker var. **incondita** Arnal, n. var.

Plate 10, figures 5, 6, 7, 8; plate 11, figure 1

Variety differing from the typical by being not quite as elongate in shape and having a definite neck. Length, 0.35 to 0.45 mm.; width, 0.18 to 0.25 mm.

This variety occurs at many stations with the typical species. It has been found living in shallow water at several stations. It is intermediate in outline between *Q. crassa* d'Orbigny (1850) and *Q. costata* d'Orbigny but has a more developed neck than either one.

Holotype.—USC No. 4606. *Paratype.*—USC No. 4607.

Quinqueloculina subdecorata Cushman

Plate 11, figures 3, 4, 5

1918. *Quinqueloculina subdecorata* CUSHMAN, U. S. Geol. Survey Bull. 676, p. 71, pl. 29, figs. 3a-c.

Specimens of this species are identical with the type which was described from the Miocene of Florida. Only dead specimens have been observed. This species may have been living in the Salton Sea, as numerous individuals have been observed, but it has not become adapted to the present conditions in the lake.

Hypotype.—USC No. 4608.

Reophax nana Rhumbler

Plate 9, figures 13, 14, 15, 16

1913. *Reophax nana* RHUMBLER, Ergeb. Plankton Exped. Humbolt Stiftung, vol. 3, pt. 2, p. 471, pl. 8, figs. 6 to 12.

1953. *Reophax nana* PARKER, PHLEGER and PEIRSON, Cushman Foundation Foram. Research, Special Pub. 2, p. 13, pl. 1, fig. 11.

This species was originally described from the Recent in shallow water off Brazil. Other records are from Long Island Sound (Parker, 1952) and the San Antonio region in Texas. In the Salton Sea, living and dead specimens occur in shallow water and in the deltas of the New and Alamo Rivers.

Hypotypes.—USC Nos. 4609, 4610, 4611.

Saccammina sphaerica Sars

Plate 9, figure 17

1872. *Saccammina sphaerica* SARS, Christiana, Forhanell, Norge, Aar 1871, p. 250.

Two specimens have been found at one station in the marshes of the delta of New River. It was recorded previously from Recent sediment in a Norwegian fjord.

Hypotype.—USC No. 4612.

Streblus beccarii (Linné) var. **sobrinus** (Shupack)

Plate 12, figures 1, 2, 3

1934. *Rotalia beccarii* (LINNÉ) var. *sobrinus* SHUPACK, Am. Mus. Novitates no. 737, p. 6, fig. 4.

1954. *Streblus beccarii* var. *sobrinus* BANDY, U. S. Geol. Survey Prof. paper 254-F, p. 138, pl. 30, figs. 7a-c.

This species, originally described from the Recent of western Long Island, has also been recorded by Bandy from the shallow water of the Gulf of Mexico. A few specimens, apparently reworked from outcrops of the Borrego formation, have been found at one station on the eastern shore of the Salton Sea.

This species has been placed under the generic name of *Streblus*, as it has a single dorsal wall structure in cross section. This and the presence of pillars and plugs differentiate the genus *Streblus* from the genus *Rotalia*, of which the type species, *Rotalia trochidiformis*, has a multiple dorsal wall structure in cross section.

Hypotypes.—USC Nos. 4613, 4614.

Streblus beccarii (Linné) var. **tepidus** (Cushman)

Plate 12, figures 4, 5, 6, and 17

1926. *Rotalia beccarii* (LINNÉ) var. *tepida* CUSHMAN, Carnegie Inst. Washington, Pub. 344, p. 79, pl. 1.

1951. *"Rotalia" beccarii* var. *tepida* PHLEGER and PARKER, Geol. Soc. America Memoir 46, pt. 2, p. 23, pl. 12, figs. 7a, b.

1954. *Streblus beccarii* var. *tepidus* BANDY, U. S. Geol. Survey, Prof. paper 254-F, p. 138.

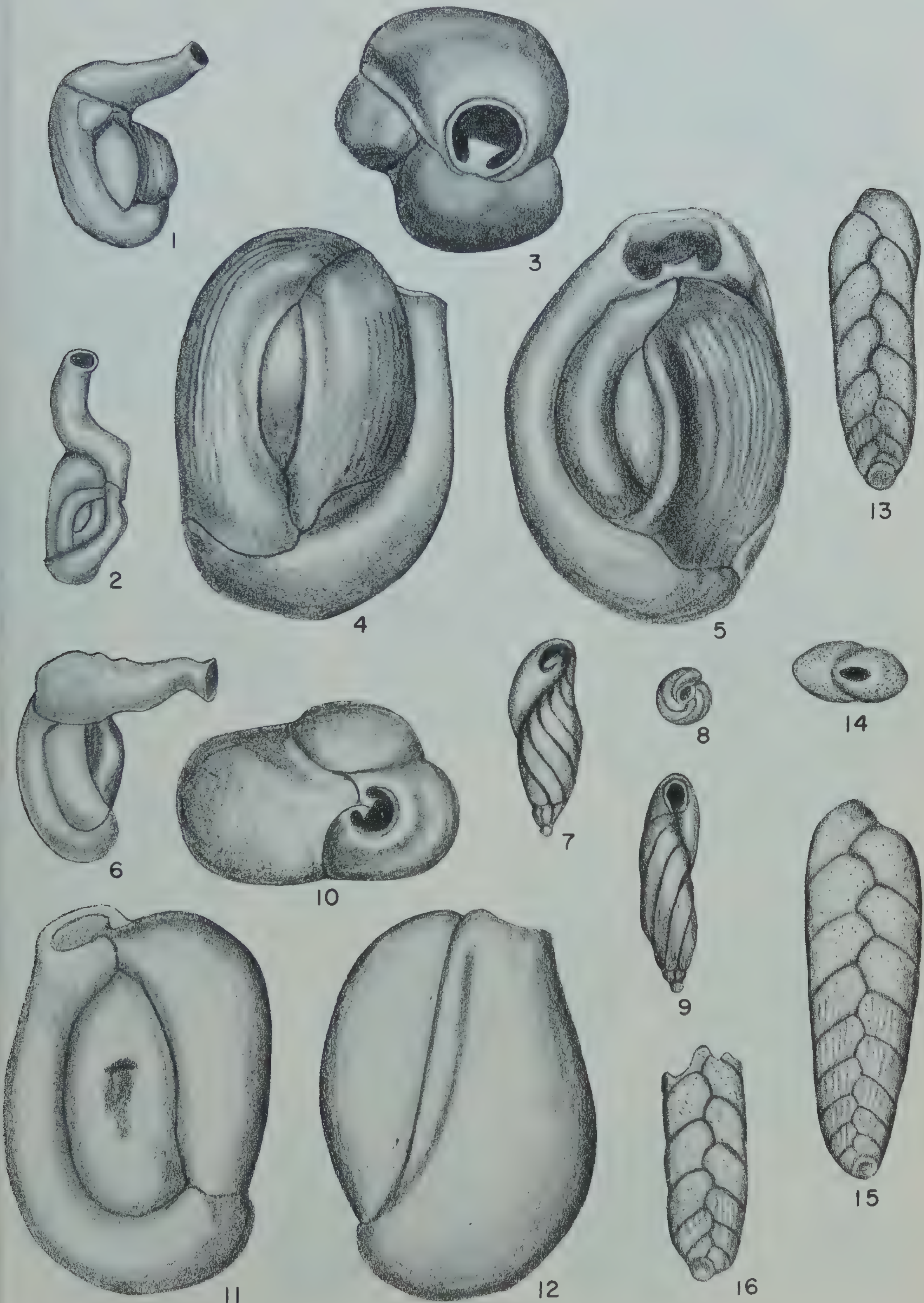
This species was originally described from Recent sediments in San Juan Harbor, Puerto Rico. Many records exist in the literature as well as the above mentioned publications. Natland (unpublished doctoral dissertation, University of California at Los Angeles) also noted its presence in the Pleistocene of the Ventura Basin, California. It is a shallow water species well adapted to brackish waters.

Reasons for the generic position have been given in the discussion of *Streblus beccarii* var. *sobrinus*. Living and dead specimens are found in great abundance at most of the stations. However, the largest percentages occurred in the central part of the Salton Sea.

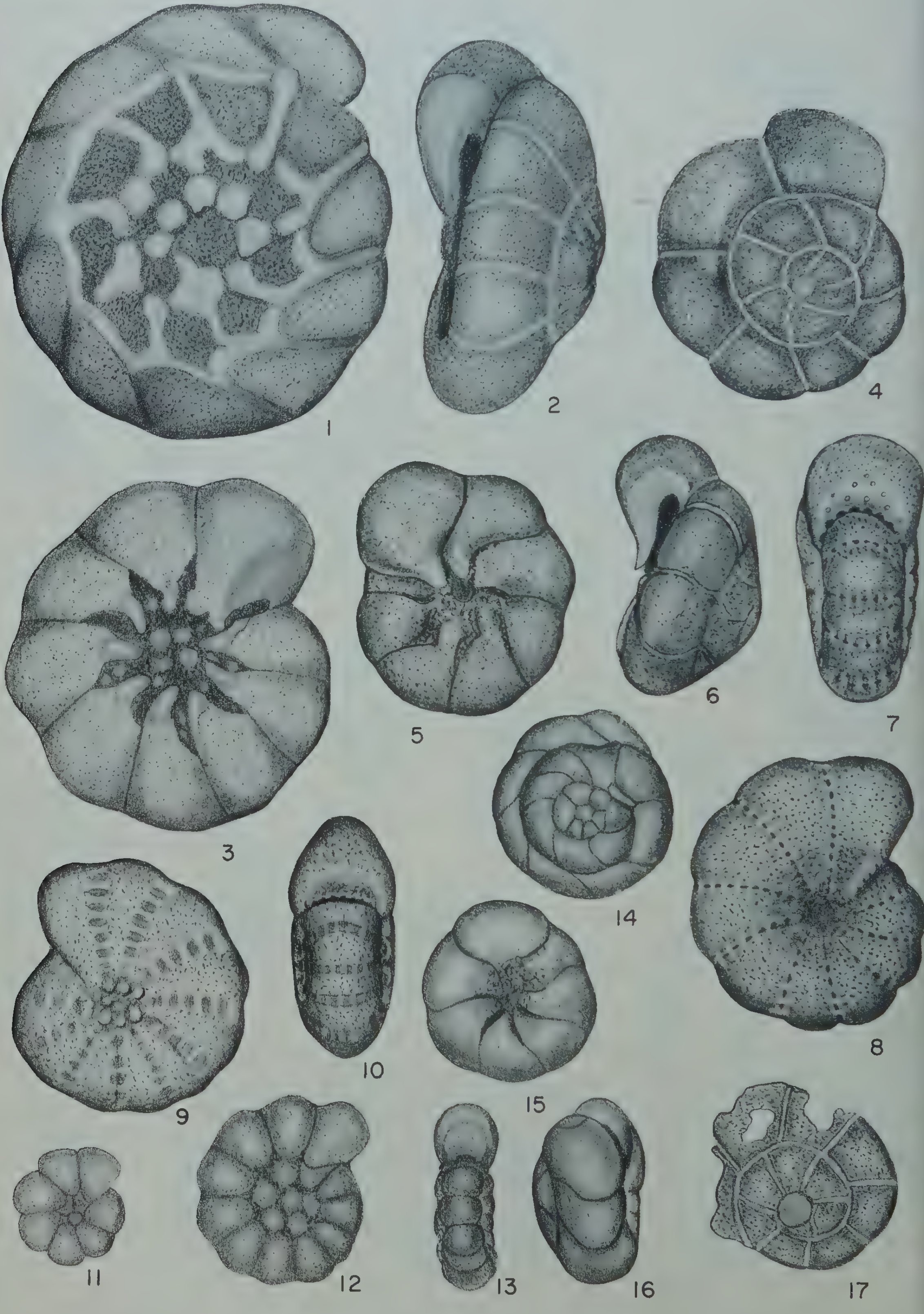
Hypotype.—USC No. 4615.

EXPLANATION OF PLATE 11

FIGS.		PAGE
1.	*Quinqueloculina rhodiensis* Parker var. *incondita* Arnal, n. var., × 124; abnormal specimen, hypotype, USC No. 4622.	39
2, 6.	*Miliolidae*, × 124; abnormal specimens not specifically identifiable.	
3, 4, 5.	*Quinqueloculina subdecorata* Cushman, × 124; 3, apertural view; 4, side view, hypotype, USC No. 4608; 5, side view of another specimen.	40
7, 8, 9.	*Buliminella elegantissima* (d'Orbigny), × 124; 7, side view, hypotype, USC No. 4590; 8, apertural view; 9, side view, hypotype, USC No. 4591.	37
10, 11, 12.	*Triloculina sidebottomi* (Martinotti), × 90; 10, apertural view; 11, side view; 12, side view, hypotype, USC No. 4620.	41
13, 14, 15.	*Bolivina striatula* Cushman, × 124; 13, side view, hypotype, USC No. 4588; 14, apertural view; 15, side view, hypotype, USC No. 4589.	37
16.	*Bolivina* probably *B. striatula*, × 124; specimen showing etching of the apertural end.	37



ARNAL: SALTON SEA RHIZOPODA



Arnal: Salton Sea Rhizopoda

Streblus irridescens Arnal, n. sp.

Plate 12, figures 14, 15, 16

Test, small, trochospiral, plano-convex, ventral side flat or slightly concave, umbilical region filled with fine raised processes extending halfway along the sutures; chambers slightly inflated, increasing very slightly but very regularly as added; three whorls making up about 20 chambers visible on the dorsal side, only last whorl made up of 7 chambers visible on the ventral side; sutures depressed on both sides, curved and meeting the periphery tangentially on the dorsal side, sutures sigmoid on the ventral side; wall smooth, very finely perforate, irridescent; aperture a low arched opening extending to the umbilicus. Diameter, 0.25 to 0.30 mm.; thickness, 0.10 to 0.16 mm.

This species resembles *Rotalia hozanensis* Nakamura (1937), but the periphery is less lobulate and the dorsal sutures are more curved. Adult specimens show very little variation in size. The irridescence of the test is very characteristic.

Holotype.—USC No. 4616. *Paratype.*—USC No. 4617.

Textularia earlandi Parker

Plate 9, figures 1, 2, 3

1952. *Textularia earlandi* PARKER, Mus. Comp. Zool. Bull., vol. 106, no. 10, p. 458.

This species was originally described from Recent sediments near Monaco, France. Walton (1955) reported it from the coastal marshes of Todos Santos Bay, Baja California. In the Salton Sea, living and dead specimens of this species were observed in some coastal stations and in the marshes of the New and Alamo River deltas.

Hypotypes.—USC Nos. 4618, 4619.

Triloculina sidebottomi (Martinotti)

Plate 11, figures 10, 11, 12

1920. *Sigmoilina sidebottomi* MARTINOTTI, Atti. Soc. Ital. Sci. Nat., vol. 59, pl. 2, fig. 29, text figs. 59-61.

1953. *Triloculina sidebottomi* PARKER, PHLEGER and PEIRSON, Cushman Foundation Foram. Research, Special Pub. 2, p. 14, pl. 2, figs. 25-28, text figs. 3, 4.

A few dead specimens have been found at one station on the western shore of the Salton Sea. This species was originally described from Recent sands on a beach of Tripoli, Libya.

Hypotype.—USC No. 4620.

THECAMOEBINA

Genus **Difflugia** Leclerc

Genus description (after Kudo, 1954).—Test variable in shape, but generally circular in cross-section, composed of cemented sand grains, diatoms and other foreign bodies; aperture terminal.

Difflugia oblonga Ehrenberg

Plate 9, figures 20, 21, 22

Test pyriform, flask-shaped, or ovoid; neck variable in length, aperture terminal, typically circular, test composed of angular sand grains and diatoms (after Kudo, 1954, pp. 482-483). The discussion of Bolli and Saunders (1954) demonstrated that this species, erroneously described as a foraminifer, should be placed in the thecamoebian genus *Difflugia.*

Parker (1952) noted the presence of this fresh water organism in the Connecticut River and it occurs in the Guadalupe River, in the San Antonio area, in Texas. Living and dead specimens were observed in the marshes of the New and Alamo River deltas.

Hypotypes.—USC Nos. 4602, 4603.

Difflugia urceolata Carter

Plate 9, figures 10, 11, 12

A large ovoid, rotund test, with a short neck and a rim around the aperture, (after Kudo, 1954, pp. 483). As mentioned by Bolli and Saunders (1954), this species was erroneously described as a foraminifer on several occasions.

Cushman and Bronnimann (1948) recorded this organism from inshore mud, brackish water, Mangrove swamp, Trinidad, B.W.I. Parker (1952) recorded it from the Connecticut River adjacent to Long Island

EXPLANATION OF PLATE 12

FIGS.		PAGE
1, 2, 3.	*Streblus beccarii* (Linné) var. *sobrinus* (Shupack), × 124; 1, dorsal view, hypotype, USC No. 4613; 2, apertural view; 3, ventral view; hypotype, USC No. 4614.	40
4, 5, 6.	*Streblus beccarii* (Linné) var. *tepidus* (Cushman), × 124; 4, dorsal view; 5, ventral view; 6, apertural view, hypotype, USC No. 4615.	40
7, 8.	*Elphidium tumidum* Natland, × 124; 7, apertural view; 8, side view, hypotype, USC No. 4595.	39
9, 10.	*Elphidium gunteri* Cole, × 124; 9, side view; 10, apertural view, hypotype, USC No. 4594.	39
11, 12, 13.	*Nonion saltonensis* Arnal, n. sp., × 124; 11, side view, paratype, USC No. 4600; 12, side view; 13, apertural view, holotype, USC No. 4599.	39
14, 15, 16.	*Streblus irridescens* Arnal, n. sp., × 124; 14, dorsal view, holotype, USC No. 4616; 15, ventral view; 16, apertural view, paratype, USC No. 4617.	41
17.	*Streblus beccarii* (Linné) var. *tepidus* (Cushman), × 124; specimen showing etching of the test.	40

Sound, and in the Guadalupe River, San Antonio region, Texas. In the Salton Sea, this fresh water species is restricted to New River stations.

Hypotypes.—USC Nos. 4596, 4597.

Genus **Pseudodifflugia** Schlumberger

Genus description (after Kudo, 1954).—Test ovoid, usually rigid, with sand grains and foreign bodies, circular or elliptical in cross-section, aperture terminal.

Pseudodifflugia gracilis Schlumberger

Plate 9, figures 18, 19

Test yellowish or brownish, subsphaerical with sand grains, aperture round without a neck (after Kudo, 1954, p. 487). This species fits well the above generic and specific description, however it may be a new variety because of its crenulated aperture. A few specimens were found at one station in the marshes of the New River delta.

Hypotype.—USC No. 4621.

BIBLIOGRAPHY

Bandy, O. L., 1950, Some later Cenozoic Foraminifera from Cape Blanco, Oregon: Jour. Paleontology, Vol. 24, pp. 269-281.

———, 1953, Ecology and paleoecology of some California Foraminifera. Part 1. The frequency distribution of Recent Foraminifera off California: Jour. Paleontology, Vol. 27, pp. 161-182.

———, 1954, Distribution of some shallow water Foraminifera in the Gulf of Mexico: U. S. Geol. Survey, Prof. Paper 254-F, pp. 125-141.

Bolli, H. M. and Saunders, J. B., 1954, Discussion of some Thecamoebina described erroneously as Foraminifera: Contr. Cushman Found. Foram. Research, Vol. 5, Part 2, pp. 45-52.

Brady, H. B., Parker, W. K. and Jones, T. R., 1888, On some Foraminifera from the Abrohlos Bank: Zool. Soc. London Trans., Vol. 12, Part 7, No. 1, pp. 230.

Cole, W. S., 1931, The Pliocene and Pleistocene Foraminifera of Florida: Florida State Geol. Surv. Bull., No. 6, pp. 34.

Cushman, J. A., 1918, Some Miocene Foraminifera of the Coastal Plain of the United States: Bull. U. S. Geol. Survey, No. 676.

———, 1922, Shallow water Foraminifera of the Tortugas region: Carnegie Inst. Washington, Pub. 311.

———, 1926, Recent Foraminifera from Puerto Rico: Carnegie Inst. Washington, Pub. 344.

———, and Bronniman, P., 1948, Some new genera and species of Foraminifera from brackish water of Trinidad: Contrib. Cushman Lab. Foram. Research, Vol. 24, Pt. 1, pp. 21-28.

Kudo, R. R., 1954, Protozoology (Fourth Edition), 966 pp., Thomas Publisher, Springfield, Illinois.

Martinotti, A., 1920, Foraminiferi della spiaggia di Tripoli: Soc. Ital. Sci. Nat. Milano, Atti., Vol. 59, Fasci. 3-4, pp. 280.

Nakamura, M., 1937, New species of fossil Foraminifera from the Byoritu Beds of the oil fields of Northern Taiwan (Formosa), Japan: Trans. Japanese Jour. Geol.-Geogr., Vol. 14, Nos. 3-4, pp. 141.

Natland, M. L., 1938, New species of Foraminifera from off the West Coast of America and from the later Tertiary of the Los Angeles Basin: Bull. Scripps Inst. Oceanog., Vol. 4, No. 5, pp. 137-163.

d'Orbigny, A., 1826, Tableau méthodique de la classe des Foraminifères: Ann. Sci. Nat., Vol. 7, No. 3, pp. 245-314.

———, 1839, Voyage dans l'Amérique méridionale—Foraminifères: Strasbourg, France, LeVrault, Tome 5, Pt. 5, pp. 51.

———, 1850, Prodrome de paléontologie stratigraphique universelle des animaux mollusques et rayonnés: Paris, France, V. Masson, Vol. 2, pp. 409.

Otto, G. H., 1933, Comparative tests of several methods of sampling heavy mineral concentrates: Jour. Sed. Petrology, Vol. 3, pp. 30-39.

Parker, F. L., 1952, Foraminiferal distribution in the Long Island Sound-Buzzards Bay area: Bull. Harvard Coll. Mus. Comp. Zool., Vol. 106, No. 10, pp. 458.

———, Phleger, F. B. and Peirson, J. F., 1953, Ecology of Foraminifera from San Antonio Bay and environs, southwest Texas: Cushman Foundation for Foram. Research, Spec. Pub. No. 2.

Rhumbler, 1913, Die Foraminiferen (Thalamorphoren) der Plankton-Expedition; Zweiter Teil: Systematik: Ergeb. Plankton. Exped. Humbolt Stiftung, Vol. 3, pp. 333-476.

Roboz, Z. von, 1884, *Calcituba polymorpha,* nov. gen. nov. spec.: K. Akad. Wiss. Wien, Math-Naturw. Cl., Sitzber. Wien Bd. 88, (Jahrg. 1883), Abth. 1, Heft 2, pp. 241.

Sars, G. O., 1872, Undersogelser over Hardangerfjordens fauna. Vidersk-Selsk: Christiana, Forhandl., Christiana, Norge, Aar 1871, p. 250.

Shupack, B., 1934, Some Foraminifera from western Long Island and New York Harbor: Am. Mus. Nat. Hist. Novitates, New York, N. Y., No. 737, pp. 6.

Walton, W. R., 1952, Techniques for the recognition of living Foraminifera: Contrib. Cushman Foundation Foram. Research, Vol. 3, Pt. 2, pp. 56-60.

———, 1955, Ecology of living benthonic Foraminifera, Todos Santos Bay, Baja California: Jour. Paleontology, Vol. 29, pp. 952-1018.

APPENDIX — FREQUENCY DISTRIBUTION OF FORAMINIFERA

Name of Species	Station number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Ammobaculites salsus				16		1		1	x				
2 Bathysiphon sp.													
3 Bolivina striatula	32	50				7		8	11	11	15	2	2
4 Buliminella elegantissima	16					1		6	4	52	9	1	4
5 Calcituba simplex													
6 Elphidium gunteri	16	50	20			9			1		1	5	
7 Elphidium tumidum			80	61	77	10	66	32	10	11	22	11	20
8 Massilina protea													
9 Nonion saltonensis													
10 Quinqueloculina bellatula	32			8	5	6	1	9	5	12	12	36	21
11 Quinqueloculina rhodiensis					4	4	4	1	2	3	x	1	4
12 Quinqueloculina rhodiensis var. incondita						x			3	3	1	3	
13 Quinqueloculina subdecorata								x					
14 Reophax nana													
15 Saccammina sphaerica					1								
16 Streblus beccarii var. sobrinus													
17 Streblus beccarii var. tepidus				16	13	63	29	43	63	8	40	41	44
18 Streblus irridescens													
19 Textularia earlandi													2
20 Triloculina sidebottomi									x		x		
Total Foraminifera	6	2	9	120	178	254	112	340	412	281	491	180	88
Number of species	4	2	2	4	5	9	4	8	10	7	9	8	7
% living to total	0	0	0	47	14	16	52	2	20	10	x	3	1
Foraminiferal Number	1	1	1	57	70	105	8	1946	582	430	379	118	410

Name of species	Station number															
	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1 Ammobaculites salsus	1	5		x				1		1			1			
2 Bathysiphon sp.									1							
3 Bolivina striatula	3	3	2	1	2	9	3	9	7	2	15	2	2	9	13	1
4 Buliminella elegantissima	4		7	12	11	14	11	5	6		2		2	1	1	
5 Calcituba simplex													1	3	1	
6 Elphidium gunteri		3	2	3	1	3	2		2	2						
7 Elphidium tumidum	19	38	15	20	22	14	18	8	5	45	5	54	7	1	7	47
8 Massilina protea				x												
9 Nonion saltonensis										5		1				
10 Quinqueloculina bellatula	16	21	22	10	30	34	37	36	29	16	25	12	42	16	9	
11 Quinqueloculina rhodiensis	4	1	2	6	5	3	3	1	2		1	1	9	2	1	2
12 Q. rhodiensis var. incondita	3		8				1	2	2				2	1		
13 Q. subdecorata			4		1	3				5			1			
14 Reophax nana																
15 Saccammina sphaerica																
16 Streblus beccarii var. sobrinus																
17 S. beccarii var. tepidus	49	25	36	47	28	21	25	39	48	24	51	28	33	65	69	50
18 S. irridescens		3														
19 Textularia earlandi		1	1											1		
20 Triloculina sidebottomi	1		1	1												
Total Foraminifera	200	76	169	326	369	225	236	132	129	83	150	93	172	155	167	123
Number of species	9	9	11	9	8	8	8	8	9	8	6	7	10	9	7	4
% living to total	2	12	0	0	0	0	0	0	0	3	1	5	0	7	0	0
Foraminiferal Number	768	131	422	294	887	205	1249	188	328	47	27	9	294	179	8	9

Name of species	Station number															
	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
1 Ammobaculites salsus				1											4	
2 Bathysiphon sp.																
3 Bolivina striatula	13	1	18	4	4	20	2	8	19	16	1	1	2	29	7	7
4 Buliminella elegantissima			4	1	3			2	11	6				7	2	2
5 Calcituba simplex			3						4	2				5	2	
6 Elphidium gunteri												4			1	2
7 Elphidium tumidum	46	40	5	29	17		25	27	21	2	25	36	17	5	14	9
8 Massilina protea																
9 Nonion saltonensis					1						3	3	1			
10 Quinqueloculina bellatula	8		15	18	19			8	11	16	31	8	24	19	20	2
11 Q. rhodiensis			1	6	3				1	3	12		18	9		
12 Q. rhodiensis var. incondita									1			2			2	
13 Q. subdecorata												3	1		1	
14 Reophax nana			1											2	5	
15 Saccammina sphaerica																
16 Streblus beccarii var. sobrinus																
17 S. beccarii var. tepidus	33	59	50	41	53	80	73	55	33	56	29	42	37	24	39	79
18 S. irridescens																
19 Textularia earlandi			3												2	
20 Triloculina sidebottomi																
Total Foraminifera	24	86	115	110	98	5	60	62	141	184	69	101	93	168	121	137
Number of species	4	3	9	7	7	2	3	5	8	7	6	9	7	8	13	6
% living to total	0	0	2	33	25	0	0	1	5	13	32	9	16	6	5	1
Foraminiferal Number	1	10	70	160	41	1	6	11	44	61	23	3	96	271	145	149

Note: x means less than 1%

APPENDIX — FREQUENCY DISTRIBUTION OF FORAMINIFERA

Name of species	Station number															
	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
1 Ammobaculites salsus			x									x				
2 Bathysiphon sp.																
3 Bolivina striatula	9	7	5	4	2	1	35	7	7		26	2		10	13	13
4 Buliminella elegantissima			21	1			1				1	4	2	2	9	8
5 Calcituba simplex								8			1	2		3	2	1
6 Elphidium gunteri					6	2										
7 Elphidium tumidum	8	4	10	26	52	37	5	2	16	29	8	6	15	18	7	3
8 Massilina protea																
9 Nonion saltonensis			1		1											
10 Quinqueloculina bellatula		8	34	23	11	21	1	1			11	17	6	17	21	18
11 Q. rhodiensis		2	5	10	5	18	1				1	6	2	4	5	6
12 Q. rhodiensis var. incondita			2													
13 Q. subdecorata				3									30			
14 Reophax nana														x		
15 Saccammina sphaerica																
16 Streblus beccarii var. sobrinus						2										
17 S. beccarii var. tepidus	83	79	21	32	22	18	57	82	77	71	52	63	45	46	41	50
18 S. irridescens																
19 Textularia earlandi			x													
20 Triloculina sidebottomi																
Total Foraminifera	134	149	216	90	142	87	89	101	82	108	153	248	124	186	178	186
Number of species	3	5	9	7	8	7	6	5	3	2	7	8	6	8	8	7
% living to total	0	0	3	42	26	42	0	0	0	0	3	6	34	2	6	19
Foraminiferal Number	6	54	1536	169	36	12	2	13	1	33	36	215	570	640	1100	390

Name of species	Station number															
	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
1 Ammobaculites salsus	1								3				2			
2 Bathysiphon sp.																
3 Bolivina striatula	2		9	8	9	8	4	22				2	2	5	33	
4 Buliminella elegantissima	1	1	10		2	1	1	7						29	9	
5 Calcituba simplex							4	5								
6 Elphidium gunteri	8	2					1		2	25	4	2				
7 Elphidium tumidum	42	66	15	5	10	11	10	6	20	41	49	34	16	20	21	47
8 Massilina protea																
9 Nonion saltonensis		2											1			
10 Quinqueloculina bellatula	9	8	24	18	1		20	20	7	13	12	23	33	23	20	26
11 Q. rhodiensis	2		3	2			4	5	12	1		1	3	2	1	1
12 Q. rhodiensis var. incondita	1		1				1	2	1				2	1		
13 Q. subdecorata	3								3							
14 Reophax nana								1								
15 Saccammina sphaerica																
16 Streblus beccarii var. sobrinus		1								7						
17 S. beccarii var. tepidus	31	20	38	67	78	80	55	34	49	13	35	38	41	21	16	26
18 S. irridescens																
19 Textularia earlandi																
20 Triloculina sidebottomi									2							
Total Foraminifera	162	91	106	99	81	133	235	152	116	64	77	103	99	285	219	74
Number of species	10	7	7	5	5	4	9	9	9	6	4	6	8	7	6	4
% living to total	43	12	0	0	0	0	0	4	40	20	1	0	x	0	0	48
Foraminiferal Number	650	610	212	24	2	26	179	430	19	50	40	8	246	608	11	29

Name of species	Station number															
	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93
1 Ammobaculites salsus	2															
2 Bathysiphon sp.																
3 Bolivina striatula		1	27	13	26	5	15	1		18	12		2	3	1	2
4 Buliminella elegantissima			8			1	4			22	6	3	6	16	3	10
5 Calcituba simplex					1	1	2									
6 Elphidium gunteri	2	1				1		1	3					3	1	1
7 Elphidium tumidum	20	15	22	8	9	35	5	15	27	1	15	34	27	24	28	43
8 Massilina protea																
9 Nonion saltonensis								3	2	1				1		
10 Quinqueloculina bellatula	27	18	23		15	22	16	25	30	43	28	19	17	22	16	12
11 Q. rhodiensis	2	6				2	5	5	4	4	2	2	1	8	5	2
12 Q. rhodiensis var. incondita							2						1			
13 Q. subdecorata							1	5							6	
14 Reophax nana																
15 Saccammina sphaerica																
16 Streblus beccarii var. sobrinus																
17 S. beccarii var. tepidus	46	59	20	79	43	33	50	45	33	4	37	42	44	23	40	31
18 S. irridescens																
19 Textularia earlandi																
20 Triloculina sidebottomi																
Total Foraminifera	161	165	97	94	142	165	129	75	126	360	94	228	143	151	102	167
Number of species	6	6	5	3	5	9	9	8	6	7	6	5	7	8	8	7
% living to total	38	0	0	0	0	x	6	0	20	0	0	0	27	0	18	0
Foraminiferal Number	44	127	12	2	29	269	210	64	18	384	21	113	338	133	481	253

Note: x means less than 1%

APPENDIX — FREQUENCY DISTRIBUTION OF FORAMINIFERA

Name of species	Station number									
	94	95	96	97	98	99	100	12A	13A	14A
1 Ammobaculites salsus	x							1		3
2 Bathysiphon sp.										
3 Bolivina striatula		9	31	20	34	11	4	5	3	2
4 Buliminella elegantissima		9	8		3	7	3		4	1
5 Calcituba simplex			1					1		
6 Elphidium gunteri							2	2		
7 Elphidium tumidum	23	9	8	3	7	6	36	33	35	29
8 Massilina protea										
9 Nonion saltonensis							1			
10 Quinqueloculina bellatula	25	47	9			18	18	19	21	16
11 Q. rhodiensis	1	1					5	5	1	3
12 Q. rhodiensis var. incondita	4	7					2	4		
13 Q. subdecoráta	8	1	1				1			
14 Reophax nana			x							
15 Saccammina sphaerica										
16 Streblus beccarii var. sobrinus										
17 S. beccarii var. tepidus	38	18	42	77	52	58	29	30	35	44
18 S. irridescens					3					
19 Textularia earlandi			x							1
20 Triloculina sidebottomi										
Total Foraminifera	84	156	183	75	29	94	132	140	88	117
Number of species	7	8	9	3	5	5	10	9	6	8
% living to total	22	0	3	0	0	0	0	2	20	11
Foraminiferal Number	68	328	282	1	1	19	26	195	82	133

Note: x means less than 1%

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME IX, PART 2, APRIL, 1958

183. THE TAXONOMIC POSITION OF THE GENUS *PSEUDOEPONIDES* UCHIO, 1950

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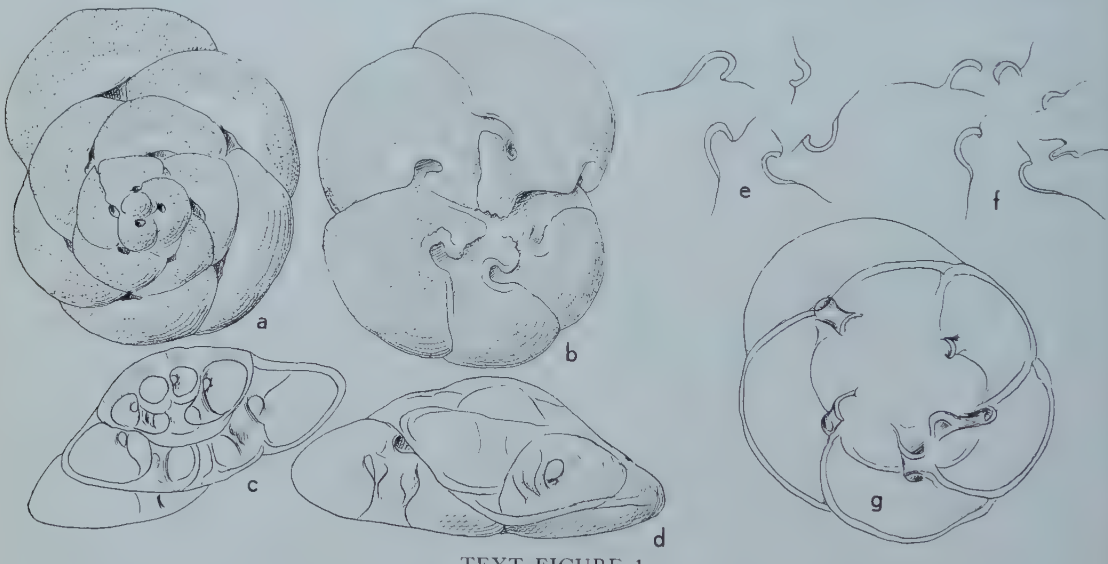
ABSTRACT

The structure of **Pseudoeponides** is discussed and its close relationship to **Streblus** suggested.

DISCUSSION

Uchio (1950, p. 190, text fig. 16) described from the Pliocene of Japan the genus *Pseudoeponides* with the type species *P. japonicus*. In the same year the same form was also described by Kuwano (1950, p. 315, text figs. 3, 10) under the name of *Epistomaria* (*Epistomariella*) *miurensis*. Oinomikado (1951, p. 17) stated, however, that the latter species was a synonym of the former. Thanks to the kindness of T. Uchio it was possible to study beautifully preserved specimens of this interesting genus, which was placed by Bermudez (1952, p. 150) in the subfamily Epistomininae obviously because of the dorsal secondary foramina. Uchio (1951, p. 38) states: "This new genus also quite resembles *Eponides* Montfort, 1808, respecting outline of the test, but the latter has no supplementary apertures. Judging from the structure of the test and aperture, this new genus may derive from *Epistomina* Terquem, 1883."

On the dorsal side of our specimens all the chambers are visible and have slanting sutures. This feature apparently gave Uchio the impression of a relationship with *Eponides*. Where the sutures of two chambers of the former whorl meet at the middle of a chamber of the next whorl, a small, entirely sutural opening is seen which in later chambers is somewhat lengthened but in the first set of chambers is rounded.



TEXT FIGURE 1

"*Pseudoeponides*" *japonicus* Uchio. × 160. a. Dorsal side, with the sutural toothplate-foramina. b. Ventral side, with the protoforamina and the lips partly covering the umbilicus and with the small deuteroforamen of the last-formed chamber also visible. c. Transverse section, showing the toothplates in each chamber running from the protoforamina towards the toothplate-foramina on the dorsal side and attached to the dorsal wall proximally to the septal deuteroforamina, which are also visible in most chambers. d. Apertural face, with the deuteroforamen in the chamber wall of the last-formed chamber; through the hyaline walls may be seen the toothplates and some septal foramina which are actually the deuteroforamina of former chambers. e, f, g. Three successive sections started at the ventral side and ground horizontally through the center of the test, sectioning the toothplates of the last-formed whorl of chambers: e. most superficial section; f. second section, showing that deeper into the chamber the toothplates become more flattened; g. the larger part of the chambers is ground down and the dorsal walls are already visible together with the ends of the toothplates which run toward the dorsal toothplate foramina and surround them at their marginal border.

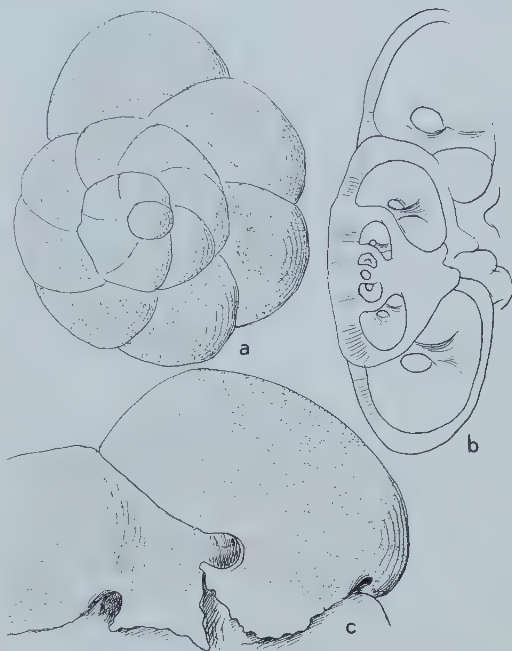
Uchio (1951, pl. 3, fig. 1) erroneously figured these openings as areal. They are, however, marginally surrounded by a typical poreless area of the chamber wall in which they are formed and, therefore, have no similarity to those found in *Höglundina* which are protoforamina placed ventrally and marginally.

On the ventral side of his species, Uchio describes and figures typical protoforamina at each suture of the chambers, such as are found in *Discopulvinulina* Hofker and *Streblus* Fischer as shown by Hofker (1951, figs. 338, 342). Since these ventral protoforamina do not occur in the genus *Eponides* it is evident that the genus *Pseudoeponides* cannot be related to it. It is therefore of great interest to try to ascertain the correct position of *Pseudoeponides* in the classification.

The ventral wall shows the typical structure of the genus *Streblus*. Not only do the characteristic loop-shaped ventral protoforamina occur but also the poreless area around them and the poreless plate covering part of the umbilicus, which is not present in *Eponides*. On the dorsal side the sutures are more slanting than in most species of *Streblus* except for *S. tepidus* (Cushman) and to a somewhat less extent typical *S. beccarii* (Linné). Moreover, a large area marginal of the typical dorsal openings mentioned above is free of pores. Such an area is also found in all species of *Streblus* although the openings connected with this area are absent in that genus. It should be pointed out that Cushman erroneously considered *Streblus*, 1817, a synonym of *Rotalia*, 1804. Since the type species of *Rotalia* is *R. trochidiformis* Lamarck, 1804, only a very few species belong to that striking genus. Most of the species hitherto described as belonging to *Rotalia* do not show the characteristics of the type species.

Thin sections show that the ventral protoforamen is connected to a toothplate which runs straight through the lumen of each chamber towards the dorsal wall where it ends proximally to the septal foramen (deuteroforamen) and forms the marginal wall of the dorsal supplementary foramen (toothplate foramen). But the toothplate differs decidedly from that of *Höglundina* or *Epistomaria* and resembles very closely the one seen in *Streblus*. In *Streblus* the toothplate likewise runs from the ventral protoforamen towards the dorsal side, but does not reach the dorsal wall. It ends proximally to the deuteroforamen (septal foramen) as in *Pseudoeponides*.

Thus, the only difference between *Pseudoeponides* and *Streblus* is found in the position of the toothplate. In the latter genus it extends slightly more vertically, reaching the dorsal wall just at the suture, whereas in *Pseudoeponides* it extends towards the inner spiral wall of each chamber and does not reach the dorsal wall. All the other features: —the hyaline walls, fine pores,



TEXT FIGURE 2

Streblus beccarii (Linné). × 160. a. Small, juvenile specimen, dorsal side, showing the poreless areas of the dorsal walls homologous with those of "*Pseudoeponides*." b. Transverse section through a microspheric test with the toothplates and the septal foramina in the same position as in "*Pseudoeponides*." c. Ventral part of large test, last-formed chambers showing protoforamina, poreless lips and deuteroforamen of last-formed chambers very much like those of "*Pseudoeponides*."

position of the pores, ventral loop-shaped protoforamina, shape of the toothplates (a hollow tube not closed at one side), narrow ventral sutural deuteroforamen and its position in respect to the toothplate—are characteristic of *Streblus*.

Pseudoeponides, therefore, is a *Streblus* in which the whole chamber is very slightly turned from the dorsal to the ventral side along its longitudinal axis so that the toothplate ends at its dorsal wall and the poreless area becomes prominent.

Toothplate-foramina have been traced in many species and they occur often at the dorsal sides of the chambers. They are found in *Robertinoides* Höglund, *Epistomaria* Galloway, and *Bulimina* d'Orbigny. The restudy of Uchio's species has led the writer to the conclusion that it would be more correct to assign it to the genus *Streblus* and to call it in future *S. japonicus* (Uchio). In that case the diagnosis of the genus *Streblus* should be emended and somewhat broadened.

The author found several other species of *Pseudoeponides* in the Pliocene and Pleistocene at localities in Holland and Belgium. These will be described in a later paper.

REFERENCES

Bermudez, P. J., 1952, Estudio sistematico de los foraminiferos rotaliformes: Min. de Minas e Hydrocarburos, Bol. Geol., vol. 2, no. 4, 230 pp.

Hofker, J., 1951, The Foraminifera of the Siboga Expedition: Part III. Siboga exped: Mon. IVa, 513 pp.

Kuwano, Y., 1950, New Species of Foraminifera from the Pliocene formations of Tama Hills in the vicinity of Tokyo: Journ. Geol. Soc. Japan, vol. 56, no. 657, pp. 311-321.

Oionomikado, T., 1951, *in* The Micropaleontologist, vol. 5, no. 2, p. 17.

Uchio, T., 1950, *in* Kavai, K., Uchio, T., Veno, M., and Hozuk, M., Natural gas in the vicinity of Otaki, Chiba-ken: Journ. Assoc. Petr. Techn., Tokyo, vol. 15, no. 4, pp. 151-219.

———, 1951, New species and genus of the Foraminifera of the Cenozoic formations in the middle part of the Boso Peninsula, Chiba-ken, Japan: Trans. Proc. Paleont. Soc. Japan, n. ser. no. 2. pp. 33-42.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH

VOLUME IX, PART 2, APRIL, 1958

RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on the Foraminifera that have come to hand.

ABRAMAVICIUTE, S. Keletas Duomenu Apie Lietuvos Tsr Virsutines Kreidos Stratigrafija Remiantis Foraminiferu Faunos Tyrimais.—Trudy Akad. Nauk Litovskoj SSR, ser. B, no. 3, 1957, p. 97-107, tables 1-4.

BECKMANN, J. P. **Chiloguembelina** Loeblich and Tappan and related Foraminifera from the Lower Tertiary of Trinidad, B. W. I.—U. S. Nat. Mus. Bull. 215, Dec. 30, 1957, p. 83-95, pl. 21, text figs. 14-16 (figures, range chart).—Sixteen species and subspecies, 3 species and 2 subspecies new, are described and illustrated and their ranges in the Paleocene to lower Oligocene of Trinidad plotted.

BESAIRIE, HENRI. La géologie de Madagascar en 1957.—Madagascar Service Géologique, 1957, p. 1-159 (mimeographed), 3 maps.—Numerous Foraminifera listed.

BOLLI, HANS M. The genera **Praeglobotruncana, Rotalipora, Globotruncana,** and **Abathomphalus** in the Upper Cretaceous of Trinidad, B. W. I.—U. S. Nat. Mus. Bull. 215, Dec. 30, 1957, p. 51-60, pls. 12-14, text fig. 10 (range chart).—Fourteen species, 4 new, are described and illustrated. Chart shows stratigraphic range in Trinidad of these 14 species and 16 others. Probable evolutionary relationships between species are discussed.

The genera **Globigerina** and **Globorotalia** in the Paleocene-lower Eocene Lizard Springs formation of Trinidad, B. W. I.—U. S. Nat. Mus. Bull. 215, Dec. 30, 1957, p. 61-81, pls. 15-20, text figs. 11-13 (range chart, evolution chart, graph).—Eight zones based on planktonic species and one zonule based on an arenaceous facies are recognized. Changes in coiling direction as well as appearance and extinction of species support the zonal separation and indicate possible hiatuses. Thirty-eight species and subspecies, 9 species and 4 subspecies new and 1 given a new name, are described and illustrated and their ranges in the Lizard Springs plotted. Their probable evolutionary relationships are discussed and some occurrences of the Lizard Springs zones outside Trinidad are noted.

Planktonic Foraminifera from the Oligocene-Miocene Cipero and Lengua formations of Trinidad, B. W. I. —U. S. Nat. Mus. Bull. 215, Dec. 30, 1957, p. 97-123, pls. 22-29, text figs. 17-21 (graph, range chart, map and section, correlation table, figures).—Eleven zones in the Cipero and 2 in the Lengua are based on planktonic species. Type section of the Cipero is re-defined. Correlation of the Cipero and Lengua with other areas is indicated. Sixty species and subspecies, 16 species and 5 subspecies new, are illustrated and described or listed, and their stratigraphic ranges in the Cipero and Lengua plotted. The species belong in 15 genera, one new: **Globorotaloides** (type species **G. variabilis** n. sp.).

Planktonic Foraminifera from the Eocene Navet and San Fernando formations of Trinidad, B. W. I.—U. S. Nat. Mus. Bull. 215, Dec. 30, 1957, p. 155-172, pls. 35-39, text figs. 25, 26 (maps, range chart).—Seven zones in the Navet and one in the San Fernando are based on planktonic species. Forty-four species, 6 new, in 11 genera are illustrated and recorded and their ranges in the Navet and San Fernando plotted. Notes on probable evolutionary relationships and preferred coiling directions are included.

BOLLI, HANS M., LOEBLICH, ALFRED R., JR., and TAPPAN, HELEN. Planktonic foraminiferal families Hantkeninidae, Orbulinidae, Globorotaliidae, and Globotruncanidae.—U. S. Nat. Mus. Bull. 215, Dec. 30, 1957, p. 3-50, pls. 1-11, text figs. 1-9 (graphs, outline drawings, map, range chart).—Revised classification of the globigerine planktonic genera in which an estimate is made of the relative importance of the various features that form the bases for family, subfamily, genus, and species classification. Terms used in describing test shape, structures, apertures, and wall are defined and illustrated. Five evolutionary trends are discussed. Stratigraphic ranges of 32 genera are shown. These 32 genera, 5 new, are described and illustrated by their type species and a few additional forms, of which 7 are new. Twenty-four additional generic names are considered, 23 placed in synonymy and 1 a homonym. The 4 families are subdivided into 7 subfamilies, of which 4 are new: Planomalininae, Hastigerininae, and Cassigerinellinae in the Hantkeninidae and Catapsydracinae in the Orbulinidae. New genera are: **Clavigerinella** (type species **C. akersi** n. sp.), **Globigerapsis** (type species **G. kugleri** n. sp.), **Porticulasphaera** (type species **Globigerina mexicana** Cushman), **Catapsydrax** (type species **Globigerina dissimilis** Cushman and Bermudez), and **Abathomphalus** (type species **Globotruncana mayaroensis** Bolli).

BRADSHAW, JOHN S. Laboratory studies on the rate of growth of the foraminifer, "**Streblus beccarii** (Linné) var. **tepida** (Cushman)".—Jour. Paleontology, v. 31, no. 6, Nov. 1957, p. 1138-1147, text figs. 1-5 (sketch and graphs).—Interesting results of experiments on precise effects of temperature and salinity on growth rate and reproductive activity.

BROTZEN, FRITZ, and POZARYSKA, KRYSTYNA. The Paleocene in central Poland.—Acta Geol. Polonica, v. 7, 1957, p. 273-280.—Lists of Foraminifera.

CARTER, D. J. The distribution of the foraminifer **Alliatina excentrica** (di Napoli Alliata) and the new genus **Alliatinella.**—Palaeontology (Pal. Assoc. London), v. 1, pt. 1, Nov. 1957, p. 76-86, pl. 14, text figs. 1, 2.—Geographic distribution of **A. excentrica** is extended to Anglo-Belgian basin where its extermination may mark the Pliocene-Pleistocene boundary. **Alliatinella** (type species **A. gedgravensis** n. sp.) differs from **Alliatina** in being trochospirally coiled and having accessory chambers only on ventral side.

CHANG, LI-SHO. A restudy of "**Clavulina subangularis** Ishizaki" and its stratigraphic significance in Taiwan. —Formosan Sci., v. 11, no. 3, Sept. 1957, p. 111-117, pls. 1, 2, text figs. 1, 2, (map, thin section sketches), tables 1, 2.—Two species from middle Miocene to lower Pliocene beds are combined and placed as synonyms of **Clavulinoides szaboi.**

COLOM, GUILLERMO, and MURAOUR, PIERRE. Les Fossiles du Miocène Inférieur (Burdigalien) de Basse-Kabylie (Microfaune by G. COLOM).—Publ. Serv. Carte Géol. Algérie (n. sér.), Bull. no. 8, 1956, p. 217-249, pls. 1-8, tables 1, 2.—A pelagic fauna listed and some of the species illustrated.

FUJITA, YUKINORI, and ITO, SHICHIRO. A study of the foraminiferal assemblages from the Miocene formation, Date district, Fukushima Prefecture, Japan (in Japanese with abstract and species descriptions in English).—Journ. Geol. Soc. Japan, v. 63, no. 744, Sept. 1957, pp. 497-513, pl. 10, text figs. 1-4 (map, section, graphs).—Quantitative analysis of the Foraminifera, ecologic interpretation, and subdivision of the Date formation into members. Part of the fauna, including 10 new species, is illustrated.

HAMILTON, EDWIN L. The last geographic frontier: the sea floor.—Sci. Monthly, v. 85, no. 6, Dec. 1957, p. 294-314, text figs. 1-13.—Excellent summary and interesting reading.

HILTERMANN HEINRICH, and KOCH, WILHELM. Revision der Neoflabellinen (Foram.) I. Teil: **Neoflabellina rugosa** (d'Orb.) und ihre Unterarten.—Geol. Jahrb., Band 74, July 1957, p. 269-303, pls. 7-14, text figs. 1-5, table 1.—Diagnosis of the species and excellent photographs. Three subspecies are recognized.

Die geologischen Aufschlüsse des Schachtes Graf Bismarck 10 der Deutschen Erdöl-Aktiengesellschaft in Gelsenkirchen im Ruhrgebiet. IV. Biostratigraphische Ergebnisse im Schacht Graf Bismarck 10 mittels Foraminiferen.—Geol. Jahrb., Band 74, July 1957, p. 327-331, 1 range chart.—Distribution and abundance shown for 12 of the most significant species and subspecies in the Upper Cretaceous part of the section.

HO, C. S., TSAN, S. F., and TAN, L. P. Geology and coal deposits of the Chichitashan area, Nantou, Taiwan.—Bull. Geol. Survey Taiwan, No. 9, Dec. 1956, p. 1-64, pl. 1 (geol. map and sections), text figs. 1, 2 (maps), tables 1-3.—Smaller Foraminifera listed from several Tertiary formations.

IKEBE, NOBUO. Cenozoic Biochronology of Japan. Contributions to the Cenozoic Geohistory of Japan. Part 1.—Journ. Instit. Polytechnics, Osaka City Univ., v. 1, no. 1, ser. G, Geoscience, March 1954, p. 73-86, text figs. 1-5, tables 1, 2.—Ranges of larger Foraminifera in terms of the Indonesian letter classification.

KANUMA, MOSABURO, and SAKAGAMI, SUMIO. **Mesoschubertella,** a new Permian Fusulinid genus from Japan.—Trans. Proc. Pal. Soc. Japan, n. ser., No. 26, June 15, 1957, p. 41-46, pl. 8, 1 text fig.—Two new species are included in the new genus.

LEHMANN, E. P. Statistical study of Texas Gulf Coast Recent foraminiferal facies.—Micropaleontology, v. 3, no. 4, Oct. 1957, p. 325-356, pls. 1-3, text figs. 1-10, tables 1-5.—Faunal analysis by statistical methods reveals presence of 12 facies in the Matagorda Bay area. Distribution of facies agrees with physiographic and oceanographic features. The determining ecologic factors probably are salinity, organic content of sediments, turbulence, and biologic competition. Excellent photographs in stereo-pairs.

LOEBLICH, ALFRED R., JR. The foraminiferal genus **Halyphysema** and two new tropical Pacific species.—Proc. U. S. Nat. Mus., v. 107, no. 3385, Jan. 9, 1958, p. 123-126, pl. 1.

LOEBLICH, ALFRED R., JR., and TAPPAN, HELEN. Correlation of the Gulf and Atlantic Coastal Plain Paleocene and lower Eocene formations by means of planktonic Foraminifera.—Journ. Paleontology, v. 31, no. 6, Nov. 1957, p. 1109-1137, text figs. 1-5 (range charts, correlation table).—Age determinations are made on the basis of and some changed correlations result from recognition of 4 zones and 2 subzones of planktonic species and genera.

Morphology and taxonomy of the foraminiferal genus **Pararotalia** Le Calvez, 1949.—Smithsonian Misc. Coll., v. 135, no. 2, Dec. 3, 1957, p. 1-24, pls. 1-5, text figs. 1-5 (stratigraphic range chart and outline drawings).—Emendation of the genus and of 6 species, and erection of 4 new species.

Planktonic Foraminifera of Paleocene and early Eocene age from the Gulf and Atlantic Coastal Plains.—U. S. Natl. Mus. Bull. 215, Dec. 30, 1957, p. 173-198, pls. 40-64, text figs. 27, 28 (range chart, correlation table). —Forty-three species, 13 new and 3 indeterminate, are described and illustrated and their occurrences and ranges indicated. Families Orbulinidae, Globorotaliidae, and Heterohelicidae are represented. Correlation table of formations is included.

Eleven new genera of Foraminifera.—U. S. Natl. Mus. Bull. 215, Dec. 30, 1957, p. 223-232, pls. 72, 73, text fig. 30.—**Hemisphaerammina** (type species **H. batalleri** n. sp.), **Zotheculifida** (type species **Textularia lirata** Cushman and Jarvis), **Berthelinella** (type species **Frondicularia paradoxa** Berthelin), **Tentifrons** (type species **T. barnardi** n. sp.), **Aeolostreptis** (type species **Bulimінella vitrea** Cushman and Parker), **Sigmavirgulina** (type species **Bolivina tortuosa** Brady), **Sejunctella** (type species **S. earlandi** n. sp.), **Eurycheilostoma** (type species **E. altispira** n. sp.), **Sestronophora** (type species **S. arnoldi** n. sp.), **Favocassidulina** (type species **Pulvinulina favus** Brady), and **Paromalina** (type species **P. bilateralis** n. sp.). **Webbinella** Rhumbler, 1904, found to be an attached polymorphinid, is emended. Seven new species are described, and 8 others illustrated.

The foraminiferal genus **Cruciloculina** d'Orbigny, 1839. —U. S. Natl. Mus. Bull. 215, Dec. 30, 1957, p. 233-235, pl. 74.—Five species, 3 new.

MATSUI, MASARU. On the Pepe-shiru formation in the Kanayama coal-field, Central Hokkaido (in Japanese with English abstract).—Journ. Geol. Soc. Japan, v. 63, No. 740, May 1957, p. 317-322, pl. 8, text figs. 1-3 (maps, section), tables 1, 2.—Six species of Foraminifera illustrated from this Oligocene formation.

MONTANARO GALLITELLI, EUGENIA. A revision of the foraminiferal family Heterohelicidae.—U. S. Natl. Mus. Bull. 215, Dec. 30, 1957, p. 133-154, pls. 31-34,

—Emendation of the family, with 14 genera removed to other families: Plectofrondiculariidae; Bolivinitinae and Eouvigerininae of the Buliminidae; and Uvigerinidae. The remaining 9 genera comprise the family, which is separated into Guembelitriinae, new subfamily, and Heterohelicinae. **Guembelina** is suppressed as a synonym of **Heterohelix. Pseudotextularia** is emended. **Nodoplanulis** is probably an arthropod appendage. **Racemiguembelina** n. gen. (type species **Gümbelina fructicosa** Egger). Genera are illustrated, in most cases by their type species.

NAGAPPA, YEDATORE. Direction of coiling in **Globorotalia** as an aid in correlation.—Micropaleontology, v. 3, no. 4, Oct. 1957, p. 393-397, pl. 1, text figs. 1-8. —In a study of one species, from 5 stratigraphic sections in West Pakistan, coiling direction shifts to predominantly dextral, then back to sinistral, near the Eocene-Paleocene boundary.

NEMKOV, G. I. Morfologicheskie Osobennosti Stroenija Rakoviny Nummulitov I Ikh Znachenie Dlja Sistematiki.—Moscow. Moskov. geol.-raz. instit., Trudy, v. 29, 1956, p. 147-159, text figs. 1-11.—Internal and external structures of nummulites.

OKAMOTO, KAZUO, and TAI, YOSHIRO. Miocene smaller Foraminifera from the Tamatukuri Group in the area south of Izumo City, Shimane Prefecture (in Japanese with English abstract).—Journ. Geol. Soc. Japan, v. 63, no. 741, June 1957, p. 340-356, text figs. 1, 2 (map, section), tables 1, 2.—Quantitative study of rich middle Miocene assemblages. Ecologic interpretation permits the subdivision of the formation into a lower part deposited under shallow littoral conditions and an upper part deposited under open sea conditions.

PAZDRO, OLGA. On some problems in micropaleontology (in Polish).—Przeglad Geol., No. 11, 1957, p. 489-498, text figs. 1-4 (graphs).

POYARKOV, B. V. About some Foraminifera from the Famenian and Tournaian deposits of West Spurs of Tjan-Shan (in Russian).—Leningrad Univ., Vestnik, No. 12, Ser. Geol. Geogr., no. 2, 1957, p. 26-41, map, tables.

POZARYSKA, KRYSTYNA, and URBANEK, ADAM. Sur l'évolution de **Lagena sulcatiformis** n. sp. dans le Crétacé Supérieur en Pologne (in Polish with French summary).—Acta Palaeont. Polonica, v. 1, no. 2, 1956, p. 113-134, text figs. 1-8.—Statistical analysis of the species in four horizons in a single basin, ranging in age from lower Maestrichtian to upper Danian, shows evolution from nearly spherical to elongate forms.

REISS, Z. Notes on Foraminifera from Israel. I. Remarks on **Truncorotalia aragonensis caucasica** (Glaessner). II. **Loxostomoides,** a new Late Cretaceous and Early Tertiary genus of Foraminifera. III. **Sigalia,** a new genus of Foraminifera.—Bull. Research Council of Israel, ser. B, Biol. and Geol., v. 6B, no. 3-4, Oct. 1957, p. 239-244.—**T. aragonensis caucasica** an Eocene marker and **T. velascoensis** a Paleocene marker. **Loxostomoides** (type species **Bolivina applini** Plummer). **Sigalia** (type species **Gumbelina deflaensis** Sigal).

RIGASSI, DANILO. Faune Sannoisienne du Pont de Naves (Hte-Savoie).—162^{me} Année Arch. Sci. Phys. Nat. Genève, v. 10, fasc. 2, 1957, p. 171-184, text figs. 1, 2 (map, photograph).—A meager fauna is listed and illustrated.

SACAL, VINCENT, and DEBOURLE, ANDRÉ. Foraminifères d'Aquitaine, 2^{e} partie, Peneroplidae à Victoriellidae.—Soc. Géol. France Mém. 78, 1957, p. 1-88, pls. 1-35.—Excellent photographs of 345 species and varieties, of which 11 are new, from beds ranging between Miocene and Upper Cretaceous.

SCHÜTZNEROVA-HAVELKOVA, VENCESLAVA. Vorkommen von Miozen-sedimenten im tal der Punkva östlich von Blansko (in Czech with German summary).—Casopis pro Min. Geol., roc. II, no. 3, 1957, p. 318-331, photos 1-5, text figs. 1-3 (map, columnar section, graph).

SIPLE, GEORGE E. Carolina Geol. Soc. Guidebook for the South Carolina Coastal Plain Field Trip, November 16-17, 1957, Open-file report, November 1957, p. 1-51 (mimeographed), text figs. 1-3 (maps), table 1 (correlation table).—Includes numerous lists of Foraminifera identified by S. M. HERRICK from Tertiary and Upper Cretaceous formations.

SMITH, BERNICE YOUNG. Lower Tertiary Foraminifera from Contra Costa County, California.—Univ. Calif. Publ. Geol. Sci., v. 32, No. 3, Sept. 11, 1957, p. 127-241, pls. 17-32, text figs. 1-5 (maps, columnar sections, distribution charts).—One hundred eighty-one species and varieties, 11 species and 9 varieties new, recorded and illustrated from Paleocene and Eocene formations. Notes on paleoecology and correlation with California zones.

TAPPAN, HELEN. New Cretaceous index Foraminifera from northern Alaska.—U. S. Natl. Mus. Bull. 215, Dec. 30, 1957, p. 201-222, pls. 65-71, text fig. 29 (correlation chart).—Thirty-four new species included in 24 genera, 3 new: **Psamminopelta** (type species **P. bowsheri** n. sp.), **Nanushukella** (type species **N. umiatensis** n. sp.), and **Pallaimorphina** (type species **P. ruckerae** n. sp.).

TERNEK, ZATI. The lower Miocene (Burdigalian) formations of the Adana Basin, their relations with other formations, and oil possibilities.—Bull. Min. Research Explor., Instit. Turkey, No. 49, 1957, p. 60-80, pls. 1-3 (maps, sections), photos 1-6, text figs. 1-12 (sections).—Foraminifera listed.

TODD, RUTH. Foraminifera from Carter Creek, northeastern Alaska.—U. S. Geol. Survey Prof. Paper 294-F, 1957 (Jan. 13, 1958), p. 223-235, pls. 28, 29, text figs. 81, 82 (maps), tables 1, 2.—A small fauna (38 species of which 4 are new and 9 indeterminate) from the Arctic coast, interpreted as a moderately deep deposit and of Miocene or Pliocene age.

TROELSEN, J. C. Some planktonic Foraminifera of the type Danian and their stratigraphic importance.—U. S. Natl. Mus. Bull. 215, Dec. 30, 1957, p. 125-131, pl. 30, text figs. 22-24 (map, section, distribution table).—On the basis of quantitative analysis of 4 species (3 from the Midway) the Danian is considered basal Cenozoic.

TSAN, S. F., YANG, Y. T., and LIN, F. Y. Geology of the Fenghuangshan coal field, Nantou, Taiwan.—Bull.

Geol. Survey Taiwan, no. 9, Dec. 1956, p. 65-80, pl. 1 (geol. map and sections), text fig. 1 (map), table 1. —Smaller Foraminifera listed from two Miocene formations.

WADE, MARY. Morphology and taxonomy of the foraminiferal family Elphidiidae.—Washington Acad. Sci. Jour., v. 47, no. 10, Oct. 1957, p. 330-339, text figs. 1-4.—Internal structures of **Elphidium** discussed and illustrated, and **Elphidiella** suppressed as a synonym. One species of **Parrellina** from the Miocene of South Australia described as new.

WOOD, ALAN. The type-species of the genus **Girvanella** (calcareous algae).—Palaeontology (Pal. Assoc. London), v. 1, pt. 1, Nov. 1957, p. 22-28, pls. 5, 6, text fig. 1 (graphs).—Re-study of Ordovician topotype material formerly considered to belong in the Foraminifera.

WOODRING, W. P. Geology and paleontology of Canal Zone and adjoining parts of Panama.—U. S. Geol. Survey Prof. Paper 306-A, Nov. 15, 1957, p. 1-145, pls. 1-23, text figs. 1-4.—Includes lists of smaller Foraminifera identified by H. H. RENZ and P. J. BERMUDEZ from late Eocene and early Oligocene beds, together with brief notes on their significance.

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